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The State of Canada's Forests

Annual Report 2017

CANADA 150

Canada

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Photo, page 2: Raft of timber on the Ottawa River [with view of Parliament Hill], ca [1859-1916], Ottawa (Ont.),
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Table of contents

Message from the Minister of Natural Resources 3
Canada's forests by the numbers 4
Evolution of a forest nation: A short history 6
Fort McMurray fire at a glance 10
Why Canada's forests need fires 12
Learning to live with forest fires 14
Behind the fire: Science and systems for fire management 16
5 things you can learn from tree rings 18
Canada's forest sector: Leading the way in the bioeconomy 20
Canada's timber forest products 22
Sustainability indicators 24

How much forest does Canada have? 26
Indicator: Forest area 27
Indicator: Deforestation and afforestation 28
Indicator: Wood volume 29

Is timber being harvested sustainably? 30
Indicator: Area harvested 31
Indicator: Regeneration 32
Indicator: Volume harvested relative to the sustainable wood supply 33

How does disturbance shape Canada's forests? 34
Indicator: Forest diseases 35
Indicator: Forest insects 36
Spotlight: Citizen scientists and the eastern spruce budworm outbreak 38
Indicator: Forest fires 40
Indicator: Forest carbon emissions and removals 41

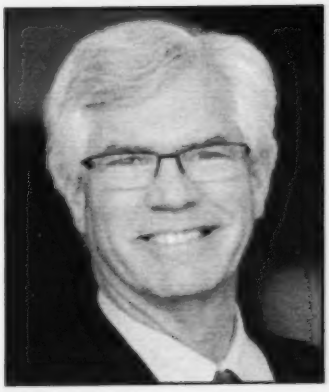
How do forests benefit Canadians? 44
Indicator: Employment 45
Indicator: Average earnings 46
Indicator: Communities 47
Spotlight: Indigenous communities and the forest economy 48

How does the forest industry contribute to Canada's economy? 50
Indicator: Gross domestic product 51
Indicator: Production 52
Indicator: Exports 53

How is the forest industry changing? 54
Indicator: Financial performance 55
Indicator: Secondary manufacturing 56
Indicator: Forest industry carbon emissions 57

Glossary: Canada's timber forest products 58
Statistical profiles 60
Sources and information 68

Message from the Minister of Natural Resources



For more than 150 years, forestry has been an integral part of the Canadian story. From timber rafts on the Ottawa River to lumber camps in British Columbia, forestry has helped to define us as a nation and shape us as a people.

It continues to do so. With the third-largest forested area on the planet, Canada boasts nearly 40 percent of the world's certified forests, far more than any other country. From Yukon to Newfoundland and Labrador, the forest sector is benefiting local communities, boosting our economy, helping to advance reconciliation with Indigenous peoples and showing us what we can accomplish when we work together.

As the industry innovates and diversifies its products, it opens up new export opportunities. Initiatives such as Generation Energy and the Canadian Council of Forest Ministers' (CCFM) Bioeconomy Framework for Canada will help to ensure that Canadian wood products win new markets and advance the broader goals of a cleaner, low-carbon future. Diversifying markets creates jobs for Canadians and helps reduce the industry's vulnerability to trade barriers.

At the same time, our forest industry is rising to the challenges presented by climate change, such as periods of low rainfall, more frequent forest fires and shifting patterns of insect outbreaks. Collective action is required to mitigate the resulting disturbances, like the forest fires that affected communities across British Columbia this summer and we are working with our partners toward solutions.

Our government believes in this industry and is excited about its future. As this year's Chair of the CCFM, Natural Resources Canada has worked with the provinces and territories to highlight forestry's central role in some of the most important issues of our time: combatting climate change, driving innovation and creating economic opportunities for rural and Indigenous communities.

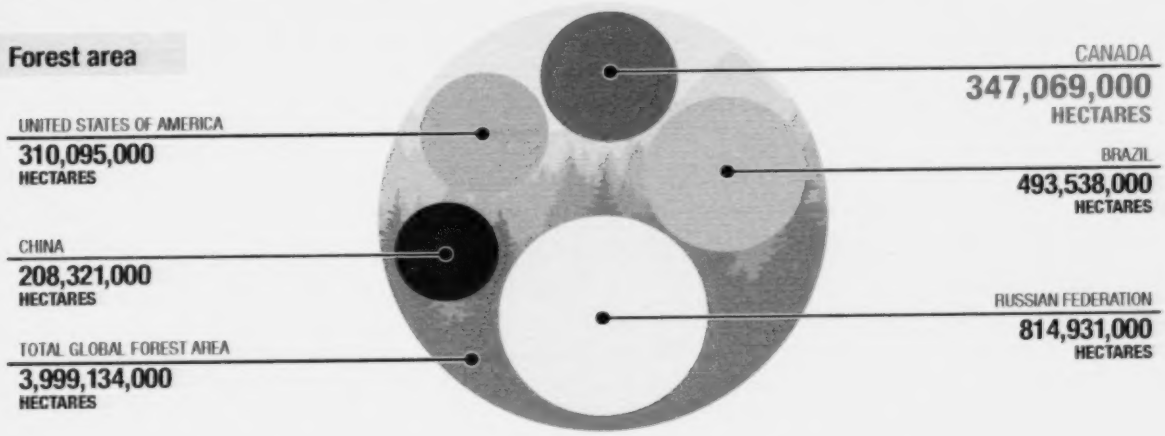
This edition of *The State of Canada's Forests* examines some of these exciting opportunities, from the emerging bioeconomy and new construction materials to innovative uses for forest products in auto parts, bioplastics, biochemicals and textiles.

Forestry has shaped Canada's history, but it is also vital to our nation's future.

The Honourable Jim Carr, P.C., M.P.,
Minister of Natural Resources

CANADA'S FORESTS BY THE NUMBERS

Forest area



Certification

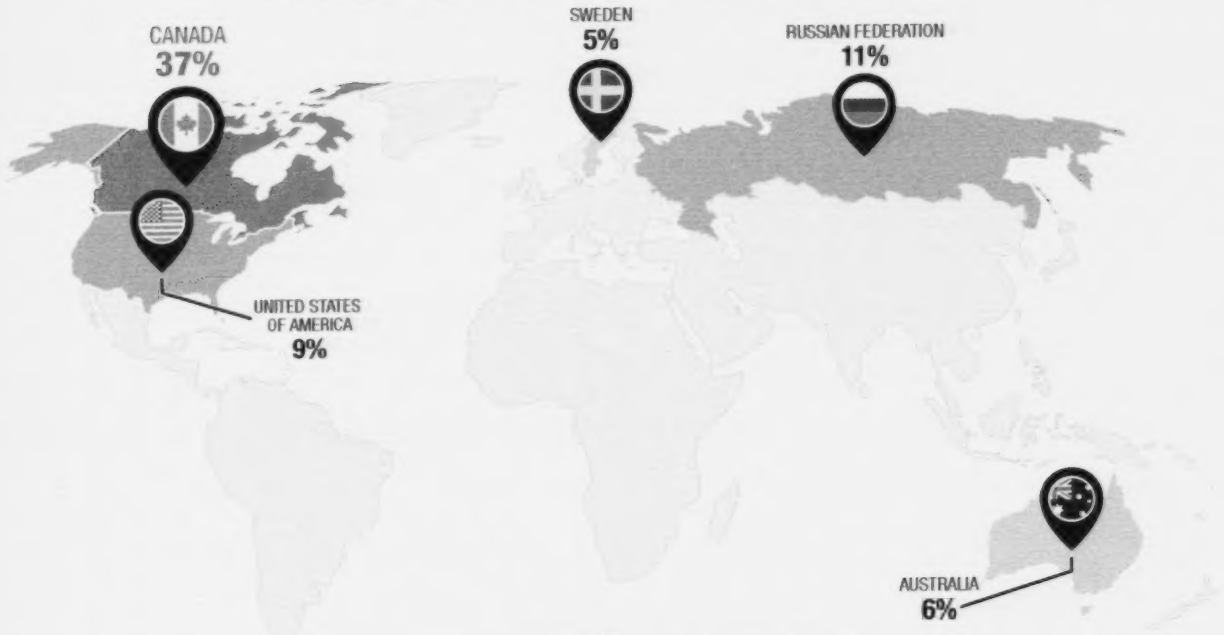
Certification provides third-party assurance that a forest is managed under recognized standards of **SUSTAINABLE FOREST MANAGEMENT**.

48% OF CANADA'S FORESTS ARE CERTIFIED

CERTIFIED FOREST AREA IN CANADA
168,000,000 HECTARES

CANADA'S FOREST AREA
347,069,000 HECTARES

37% OF THE WORLD'S CERTIFIED FORESTS ARE IN CANADA

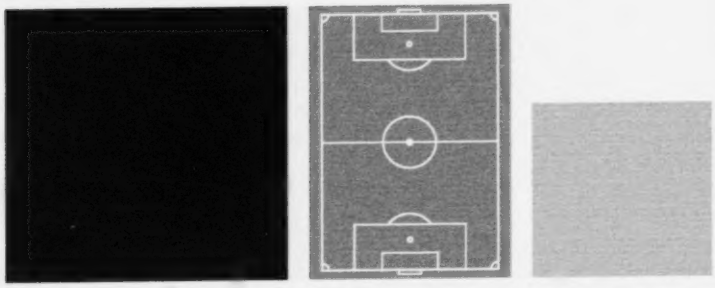


5 COUNTRIES ACCOUNT FOR 68% OF GLOBAL CERTIFIED FOREST AREA
497,854,000 HECTARES

Disturbance

5.0%	0.4%	<0.5%	<0.02%
17,631,825 HECTARES AREA DAMAGED BY INSECTS (2015)	1,404,655 HECTARES AREA BURNED BY FIRE (2016)	779,577 HECTARES AREA HARVESTED (2015)	34,100 HECTARES AREA DEFORESTED (2015)

How big is a hectare?



10,000 square metres is **1 HECTARE**

1 soccer field is **0.714 HECTARE**

1 acre is **0.405 HECTARE**

ECONOMIC BENEFITS IN 2016

The forest industry employed **211,075 PEOPLE**.

The forest industry contributed **$23.1 BILLION** to Canada's gross domestic product (GDP).

The forest industry employed **9,700 INDIGENOUS PEOPLE**.

ENVIRONMENTAL/ SOCIAL ASPECTS

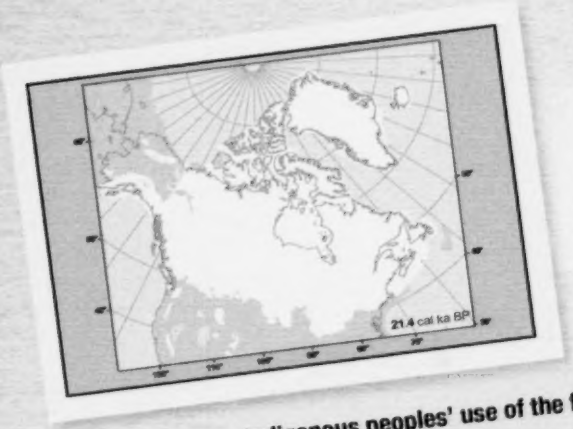
Rivers, lakes, wetlands and other water bodies occupy about **13% OF CANADA'S BOREAL ZONE**.

Canada has **24 MILLION HECTARES** of protected forest.

In 2015, over **574 MILLION SEEDLINGS** were planted in Canada's forests.

EVOLUTION OF A FOREST NATION: A SHORT HISTORY

Since long before Confederation, forests have played a crucial role in the lives of this land's inhabitants: Indigenous peoples, explorers, settlers, residents of the young Dominion of Canada and now all Canadians. Indeed, forests are part of our national identity – and not just because of our highly prized maple syrup.



End of the ice age

C. 18,000 to 13,000 years before present: The planet warms and the ice sheets covering northern North America retreat, giving plants and trees the chance to re-establish. Forests slowly reclaim the once glaciated continent.

Indigenous peoples' use of the forest

Thousands of years to pre-1600s: Indigenous peoples live in the continent's many and varied forests. Forests are culturally and spiritually important, and the way Indigenous peoples relate to and live off the resources forms the basis for their societies. They create permanent settlements in and near forests that provide food and materials for tools, shelter, medicine and clothing. In what are now southern Ontario and Quebec, Indigenous peoples practice shifting agriculture, where areas of forests are cleared for crops and then, after several years, are left to return to forest.

European settlers' arrival and use of the forest

1600s to 1700s: Explorers and other newcomers begin arriving from Europe, Asia and elsewhere. Indigenous peoples' contact with Europeans occurs first on the Atlantic and Arctic coasts and later on the Pacific coast. The fur trade is the first European harvest from the forest and the main economic activity for 200 years. Furs, taken largely from forest-dwelling animals, are the financial incentive for European exploration and settlement. Settlers clear the forest for agriculture.

Early industrial use of the forest

Early 1800s to 1890s: Forest use shifts from small-scale wood cutting by individual farmers to large-scale harvesting and milling involving thousands of people working for a handful of employers. Wood is used for fuel, in ship building and to make potash. The American Civil War and the Franco-Prussian War in Europe boost Canada's timber trade. Nearly 50% of Canada's male population work in the timber and lumber industries.

Early industrial use of the forest (cont.)

As settlers and the timber industry spread from the Atlantic region into central Canada, the northern Prairies and British Columbia, forest clearing and the rise in human-started fires dramatically alter the landscape. In south-central Canada, significant deforestation occurs.

Pressure on forests to meet demand for wooden ship building declines in the late 1800s but is replaced by the demand for railway and bridge building. The emergence of new transportation modes, notably wood-fuelled steamboats and railroad engines, adds to the need for vast amounts of firewood. The first seeds of the pulp and paper industry are sown.

Securing a sustainable timber supply

Early 1900s to 1950s: Canada's forests, especially near settled areas and close to railways and river corridors, are left seriously depleted by industrialization and fires. At the end of the First World War, most of eastern Canada's available sawlog supply is depleted.

As demand for newspapers, magazines and books grows in the United States, Canada's production of pulp and paper expands, centred mostly in the Atlantic provinces. The need for a "sustained yield" – a large and secure timber supply to support the industry – arises, and so does the idea of "perpetual forests" that need to be managed.

Forestry schools open across the country, reforestation efforts are launched, fire detection and suppression begin and professional foresters are for the first time recognized as the best equipped to make decisions about how to manage forests. The Canadian Institute of Forestry is established as Canada's first forest society and "the voice of forest practitioners."

In the post-Second World War boom, improvements in timber-processing technologies help meet growing demand for industrial timber to supply expanding world markets. At the same time, new technologies reduce demand for wood as fuel. This, combined with the end of unrestrained harvesting, eases pressures on forests.

Forest management for multiple values

1960s to 1970s: Recognition of the need for environmental protection begins to take hold in North America. Public pressure to use the forest for recreation, hunting and fishing increases.

Awareness that forests provide more than economic benefits pushes several provinces to regulate the industry and take responsibility for the environmental and socio-economic protection of values beyond timber. Forest research increases. Starting in the early 1970s, forest management planning begins to extend to non-timber elements such as wildlife, fisheries and ecological values, like old growth.

Evolution of sustainable forest management

1980s to early 2000s: The United Nations' 1987 Brundtland Report and 1992 Rio Earth Summit put the concept of "sustainable development" in motion. In response, Canada's federal, provincial and territorial governments expand forest research and forest policy to consider long-term economic and environmental needs balanced with social needs. Markets demand voluntary certification systems to define and monitor economic, environmental and social standards of forest management.

Evolution of sustainable forest management (cont.)

Greater public consultation by government and industry gives forest users more direct involvement in decision-making processes in Canada. And Indigenous communities become more directly involved in the forest industry as their access to forest tenure expands in the wake of land claim settlements, modern treaties and changes to forest management governance.

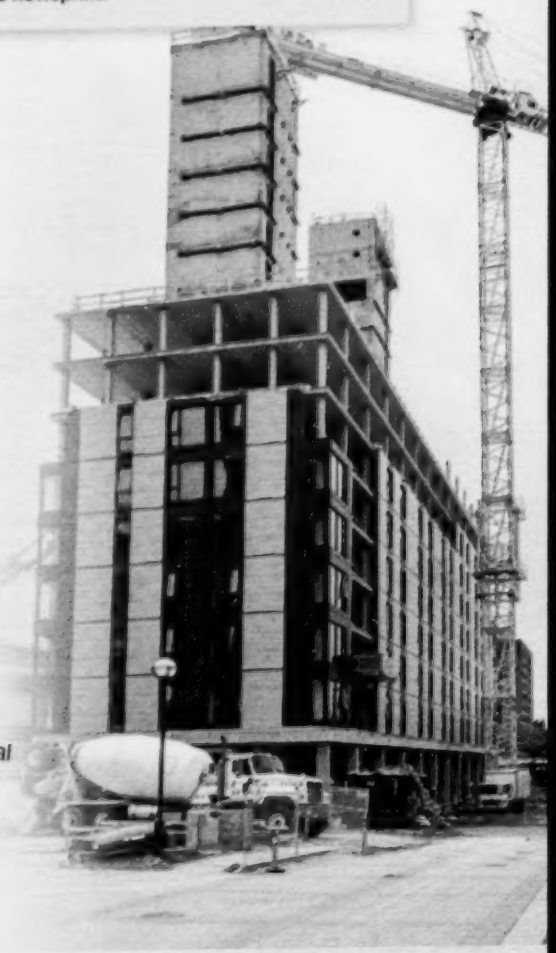
In 1982, the United States Department of Commerce begins the first in a series of investigations related to imports of certain Canadian softwood lumber products into the United States, leading to a cycle of alternating periods of trade disputes and managed trade.

The U.S. housing collapse of the mid-2000s leads to the largest drop in Canadian lumber production in more than 70 years. And the rise of electronic media reduces the demand for pulp and newsprint.

The path forward for forestry in Canada

2010s to the future: In response to the economic downturn of the previous decade, Canada's forest sector pushes to accelerate the industry's shift to bioproduct development and production. This focus on scientific research, industry transformation and market diversification (notably, moving into Asia) makes Canada a leader in bringing action and investment to the forest bioeconomy.

Canada's forests and forest sector are recognized for their key roles in mitigating climate change and the nation's transition to a low-carbon economy.



The path forward for forestry in Canada (cont.)

In 2014, Canada endorses the United Nations New York Declaration on Forests to cut global natural forest loss in half by 2020 and strive to end it by 2030. And in 2016, Canada adds its signature to the United Nations Declaration on the Rights of Indigenous Peoples, a framework for broader legal recognition and protection of the rights of Indigenous Peoples with regard to land and resources, including ownership, use, development and control.

These significant developments suggest that this country's forests will continue playing a crucial role in the lives of all Canadians for the next 150 years and beyond.

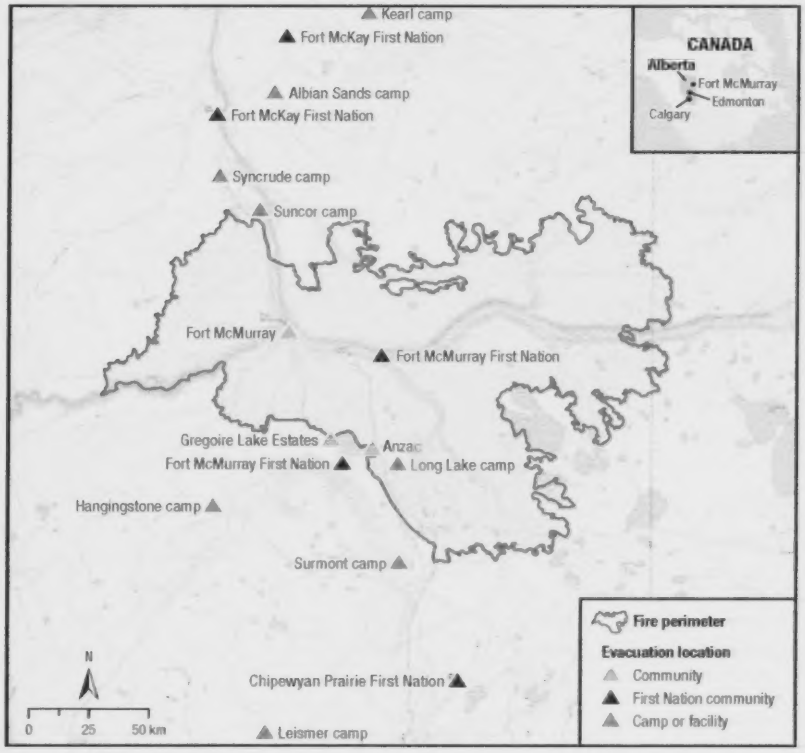
Sources: See *Sources and information* for more detail.

Fort McMurray, Alberta, May 2016

Photo credits: Getty

FORT McMURRAY FIRES AT A GLANCE

The Fort McMurray fire was the most expensive natural disaster in Canadian history.



FIRE START DATE:
MAY 1, 2016

DATE UNDER CONTROL:
JULY 5, 2016

AREA BURNED:
589,617 HECTARES

CAUSE OF FIRE:
NOT YET DETERMINED

NUMBER OF PEOPLE EVACUATED:
ABOUT 88,000
(entire population of Fort McMurray)

NUMBER OF BUILDINGS LOST:
ABOUT 2,400
(including 665 work camp units)

FIREFIGHTING COSTS:
OVER $100 MILLION

INSURANCE COSTS:
$3.77 BILLION IN CLAIMS

LOST WORK HOURS:
7.6 MILLION

IMPACT ON NATIONAL REAL GDP:
-0.4% IN Q2 2016

Number of firefighters

CANADA:	2,038
SOUTH AFRICA:	301
USA:	200
MEXICO:	42
AUSTRALIA:	1
NEW ZEALAND:	1

Size comparison

BY AREA, FORT McMURRAY IS
CANADA'S 4TH LARGEST FIRE
ON RECORD

1950 – BRITISH COLUMBIA AND ALBERTA
1,462,449 HECTARES

1995 – NORTHWEST TERRITORIES
886,994 HECTARES

2014 – NORTHWEST TERRITORIES
753,889 HECTARES

2016 – FORT McMURRAY, ALBERTA
589,617 HECTARES

2011 – ALBERTA
576,208 HECTARES

FORT McMURRAY FIRE
589,617 HECTARES

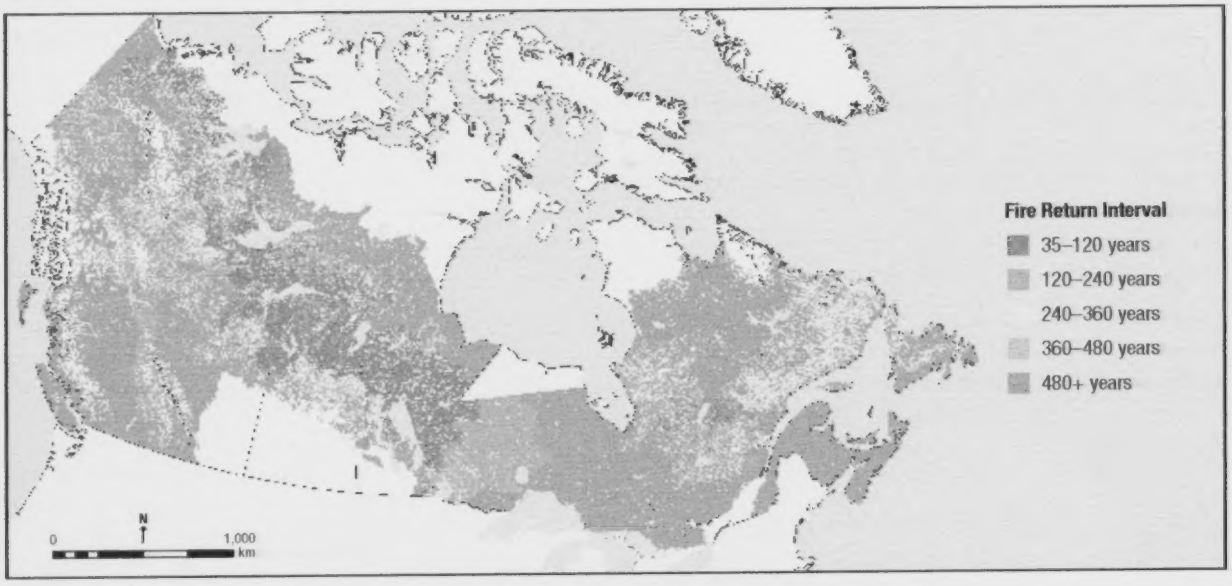
PRINCE EDWARD ISLAND
566,000 HECTARES

WHY CANADA'S FORESTS NEED FIRES

Forest fires are part of the natural cycle of regeneration and renewal in most of Canada's forests. They clean out the understory, remove flammable litter (decaying logs, leaves and needles) on the forest floor, reduce disease and the number of pests and open the forest canopy, allowing sunlight to trigger new growth.

Fire frequency across Canada

For most forests in Canada, the question is not *if* there will be a forest fire but *when* – and how intensely it will burn. Natural factors such as climate, physical landscape and the types of species present and human factors such as land use change and fire management policies determine how often fires return. In the boreal forest, fires recur as often as every 35 to 120 years. But in other forest types, for example those on the moist Pacific coast, fires are rare and may only happen several centuries apart.



Canada's forest species need fire to thrive

Nearly all plants and animals that live in Canada's forests are adapted to fire. In fact, many depend on it. The occurrence of fires at different times and intensities across the landscape creates a variety of habitats, ranging from mature forests to recently burned sites, which is important for biodiversity.

Morel mushrooms, which sprout about a year after a forest fire, are highly sought-after gourmet delicacies.

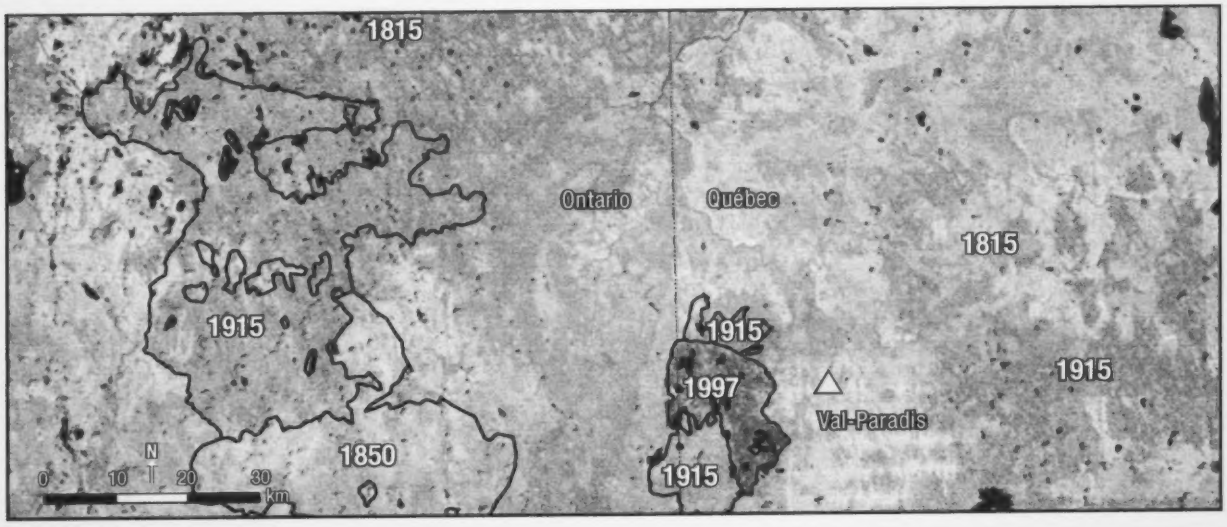
Wood-boring beetles quickly colonize newly burned trees. Woodpeckers soon follow, feeding on the beetle larvae under the bark.

Light-loving blueberries emerge after fire, with bumper crops providing essential nutrition for black bears and other animals.

Jack pine relies on environmental triggers like the heat from fire to release seeds sealed inside its cones by sticky resin.

Forest renewal after fire in Val-Paradis, Quebec, 1997

A lightning strike near Val-Paradis, Quebec, in June 1997 started the fire that burned neighbouring stands of trembling aspen (**deciduous forest**) and of mixed black spruce and jack pine (**coniferous forest**). This burn, past fires and more recent harvesting have created a mosaic of forest types across the landscape, with stands of different ages, heights and species mixes. The area burned in 1997 shows as dark pink in the satellite image. The dates of past fires surrounding Val-Paradis are indicated.



After the fire

Over time, as the trees regenerate, the burn site will become harder to tell apart from the surrounding forest. The deciduous forest grows back more quickly than the coniferous forest.

	DECIDUOUS FOREST	CONIFEROUS FOREST
3 months post-fire	Trembling aspen and leafy shrubs quickly resprout from roots and burned stumps.	Spruce and pine trees begin to grow from the seeds shed by their cones during the fire. They take longer to re-establish than the trembling aspen.
15 years post-fire	The loss of forest cover due to the fire is temporary, and an even-aged stand of aspen has been largely re-established to cover the burn site.	Faster-growing jack pine forms the top of the forest canopy, while black spruce fills in the space below. Eventually, the black spruce will overtake the pine to form the upper part of the canopy.

Learning to live with forest fires

Fires are a fact of life in most of Canada's forests and are needed to ensure forest health and renewal. In some regions fires occur naturally about once a century. In other regions they occur more frequently. Some forest plants and animals are able to survive a fire and even thrive afterwards because they have adapted to fire over thousands of years.

Unfortunately, people aren't as well adapted to fire. For those who live and work in forest areas, forest fires can be catastrophic.

Just ask anyone from Fort McMurray or another community who has been affected by forest fire. Homes, businesses, infrastructure and entire communities can be destroyed, lives can be lost or forever altered, and the economic impacts can be felt long after the fire is out. (See *Fort McMurray fire at a glance infographic*, on page 10.)

More forest fires, more people living in the forest: an increasing risk to be managed

Since 1990, on average about 7,500 fires burn 2.4 million hectares of forest in Canada each year. But the frequency and size of fires are expected to rise with climate change, as unseasonable and extreme weather becomes more common and the frequency of lightning-caused fires increases.

Rural communities, many of them Indigenous, located in remote areas where forests burn frequently are especially affected, and thousands of people are evacuated each year as a result of forest fires.

At the same time, with the growth of residential, recreational and industrial development in forested areas, there are more people in or near forests than ever before. This has increased not only the number of people affected by forest fires but also the number of forest fires started by people. This growing risk needs to be managed.

Balancing the benefits and costs of fire

The cost of fire management across Canada has risen steadily since 1970, with the sharpest increases occurring since the mid-1990s. From an average annual cost of $290 million in the early 1970s, spending on fire management reached more than $900 million in 2013, and it has topped $1 billion in more recent years. With the number of fires and the area burned each year projected to increase due to climate change, these costs are expected to continue to rise.

Until the 1970s, the goal of fire management was suppression – to put out all forest fires. But as understanding of the ecological benefits of forest fires has grown (see *Why Canada's forests need fire infographic* on page 12), it has become clear that suppressing all fires is neither ecologically wise nor physically possible.

Fire management now includes a range of options, from putting fires out to letting them burn themselves out.

Fire managers aim to balance fire's ecological benefits with the need to protect people's safety (including firefighters') and that of property, timber and other forest resources and values. Residential areas, recreational sites, valuable commercial forests and, in some cases, rare habitat and culturally significant areas or features are high priorities for fire suppression. In wilderness parks and remote forests of limited economic value where fires pose no threat to communities or infrastructure, fires are left to burn, although with careful monitoring to ensure safety.

Being FireSmart helps communities adapt to forest fires

The risks of living in the wildland-urban interface can be reduced if everyone does their part.

The wildland-urban interface is the area where homes are built near or within forests prone to fire.

Public awareness programs such as FireSmart Canada (www.firesmartcanada.ca) provide advice to community members and leaders, firefighters and companies that operate in forest areas on how to protect homes, businesses, workers, buildings and infrastructure. For example, homeowners can keep trees thinned and branches trimmed around homes and use fire-resistant materials for fences, decks and roofing. Communities can reduce fuels surrounding buildings by thinning forests, creating fire guards and planting species that have moist leaves and low amounts of sap or resin.

FireSmart also suggests measures that industry can take to reduce both risk and damage from fires, such as choosing lower-risk locations for company facilities and using safe practices in operations.

Provincial, territorial and federal governments are collaborating to advance the 2016 Canadian Wildland Fire Strategy through a range of actions. These include improving cross-jurisdictional preparedness and response capability, increasing investments in fire research innovation and enhancing commitments to resilient communities.

Clearing branches and dead wood near homes and buildings is one way communities can be FireSmart.

To date, 848 individuals have received FireSmart training, and 37 communities – including 18 Indigenous communities – are recognized under the FireSmart Canada Community Recognition Program. By taking preventive measures like these and being prepared long before fires start, people and communities in forested areas are learning to live with fire and adapt to it – just as the plants and wildlife in the forests where they live and work have done.

Source: See *Sources and information* for more detail.

Behind the fire: Science and systems for fire management

Forest fire science and management have come a long way since the days between 1920 and 1970 when "towermen" scaled wooden or steel fire towers to survey the landscape for smoke.

Today, well before the first spark of fire season, modern fire managers use sophisticated science-based technologies, systems and tools to help predict where conditions exist that could lead to new fires. Once the season is underway, with many, possibly thousands, of fires burning, they use these systems, combined with years of experience, to make complex decisions.

Fire managers ensure safety with limited resources

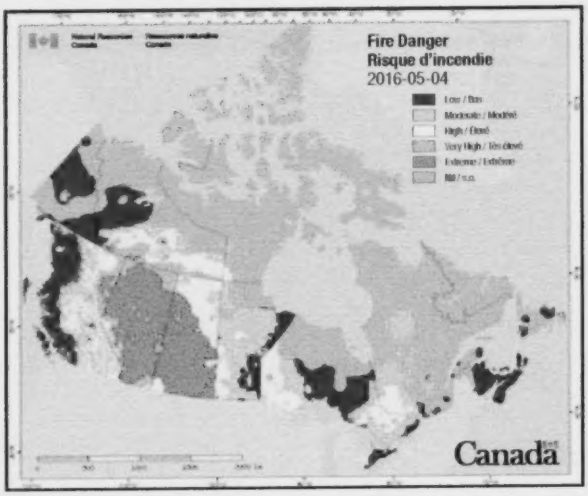
Fire managers must decide on a daily, even hourly, basis:

- where to position firefighting resources before fires start
- where to send mobile Initial Attack crews to fight new fires
- how and when to manage a fire, or whether to just monitor it
- how to best coordinate air and ground crews
- when and where to issue advisories or even evacuate communities

To determine how to best allocate limited firefighting resources, fire managers must decide which fires pose a threat to human safety, property, utilities and other public assets, wildlife habitat and timber. Safety is always the priority.

Science-based systems are essential to good fire management

Since the 1920s, fire scientists have gathered and studied data about forest fires across Canada and have conducted test fires with different tree species and under different weather conditions. This research has enabled the development of indices, information



Fire danger forecast for May 4, 2016, Canadian Wildland Fire Information System.

The **Canadian Forest Fire Danger Rating System** is the principal source of intelligence for fire management agencies in Canada and the most widely used system of its kind in the world. Used to drive fire prediction and computer modelling of fire behaviour, it includes two subsystems:

The **Canadian Forest Fire Weather Index System** provides an estimate of fire danger across the country based on measures of temperature, relative humidity, wind speed and rainfall. All of these conditions affect the potential for fires to ignite and spread.

The **Canadian Forest Fire Behavior Prediction System** helps fire managers assess how fast and far a fire could spread and how intense it might become. It is based on data such as forest and fuel type, topography, leaf moisture and weather. Results give fire managers essential information that helps them decide whether, when and how to manage or control different types of fires.

systems and models that help fire managers evaluate risks – for example, to communities, utilities, timber and recreational areas – and the options available to manage individual fires.

Researchers have also developed fire occurrence prediction models that forecast the number of lightning- and human-caused fires. Fire managers use this information to position crews where they expect fires to start. And fire smoke models enable health agencies to forecast potentially harmful smoke events and warn communities about them.

The ability to effectively manage a fire depends increasingly on both a good understanding of what is happening on the ground through direct observation and remote-sensing data, obtained largely from aircraft or satellites.

Aircraft with infrared sensors are able to detect high temperatures on the ground and can be used to map the daily growth of fires. Images from satellites are also used to detect heat sources, called "hotspots," that could indicate fires.

All of these tools extend the fire manager's view – and understanding of what's happening on the ground – well beyond what can be seen from the fire tower.

The need for fast and accurate forest fire intelligence is growing

Recent years have seen an increase in extreme fire events in Canada. Examples include fires in Slave

Lake, Alberta, in 2011; southern Northwest Territories in 2014; central Saskatchewan in 2015; and Fort McMurray, Alberta in 2016. These fires resulted in large-scale evacuations, destruction of structures and economic losses.

With more people and property located in Canada's forests, and expected increases in both fire season length and fire intensity, the need for fire intelligence has never been more important. (See *Learning to live with forest fires* on page 14.)

Canada's science-based systems are constantly being improved, growing evermore sophisticated and incorporating more data. This is putting more accurate and up-to-date information and tools in the hands of fire managers so they can protect people, property and forest values where it makes sense and is safe to do so.

Sources: See *Sources and information* for more detail.

5 THINGS YOU CAN LEARN FROM TREE RINGS

The science of tree-ring analysis is called **dendrochronology**. Examining the rings in tree cross-sections from **cookies** or sample **cores** (which are used more often) can tell you a lot about a tree, its history and the environmental conditions it grew under. Like this 218-year-old black spruce tree from northeast of Havre-Saint-Pierre, Quebec, which began life as a seedling in the boreal forest in the late 1700s.

1. Tree age

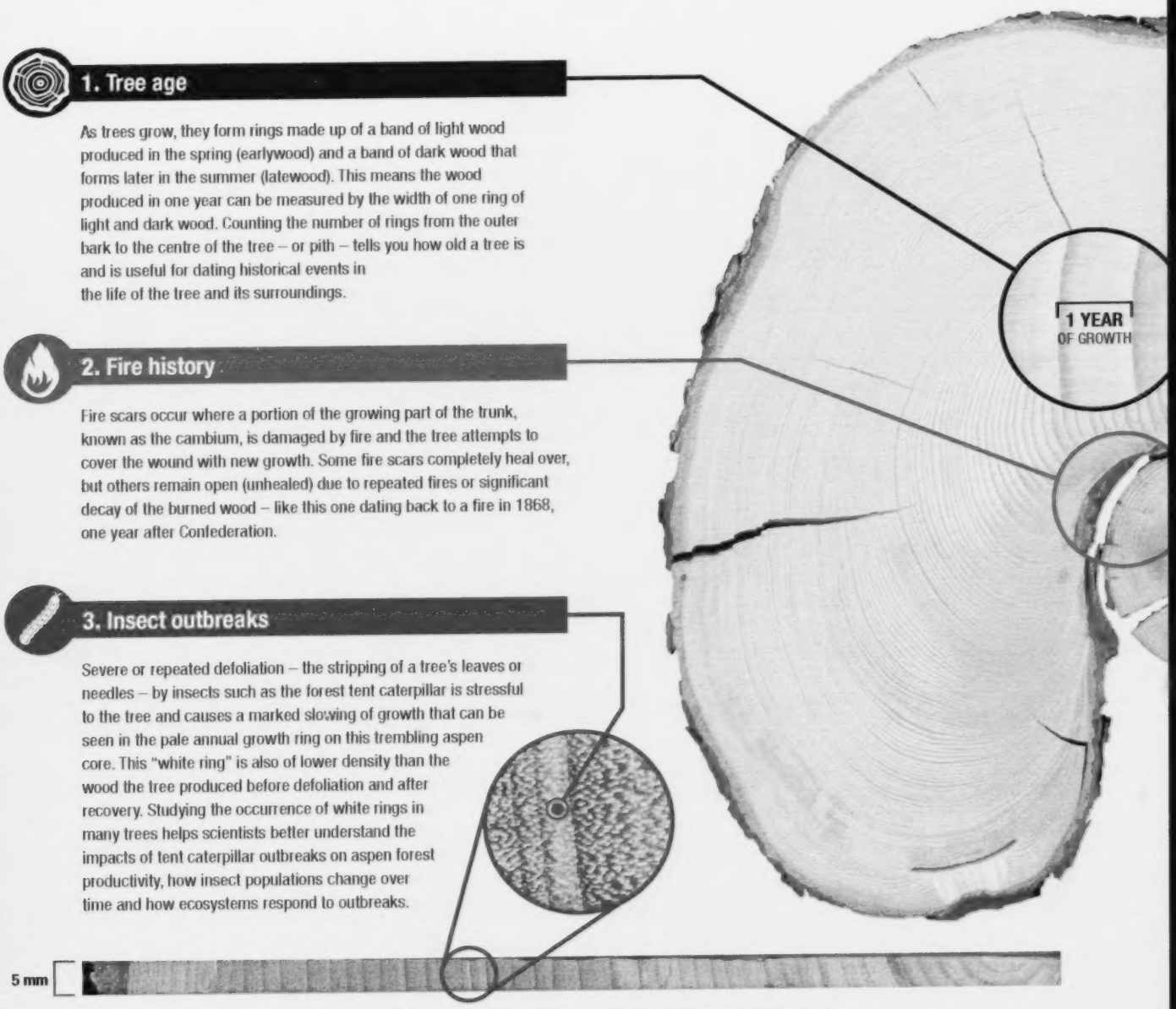
As trees grow, they form rings made up of a band of light wood produced in the spring (earlywood) and a band of dark wood that forms later in the summer (latewood). This means the wood produced in one year can be measured by the width of one ring of light and dark wood. Counting the number of rings from the outer bark to the centre of the tree – or pith – tells you how old a tree is and is useful for dating historical events in the life of the tree and its surroundings.

2. Fire history

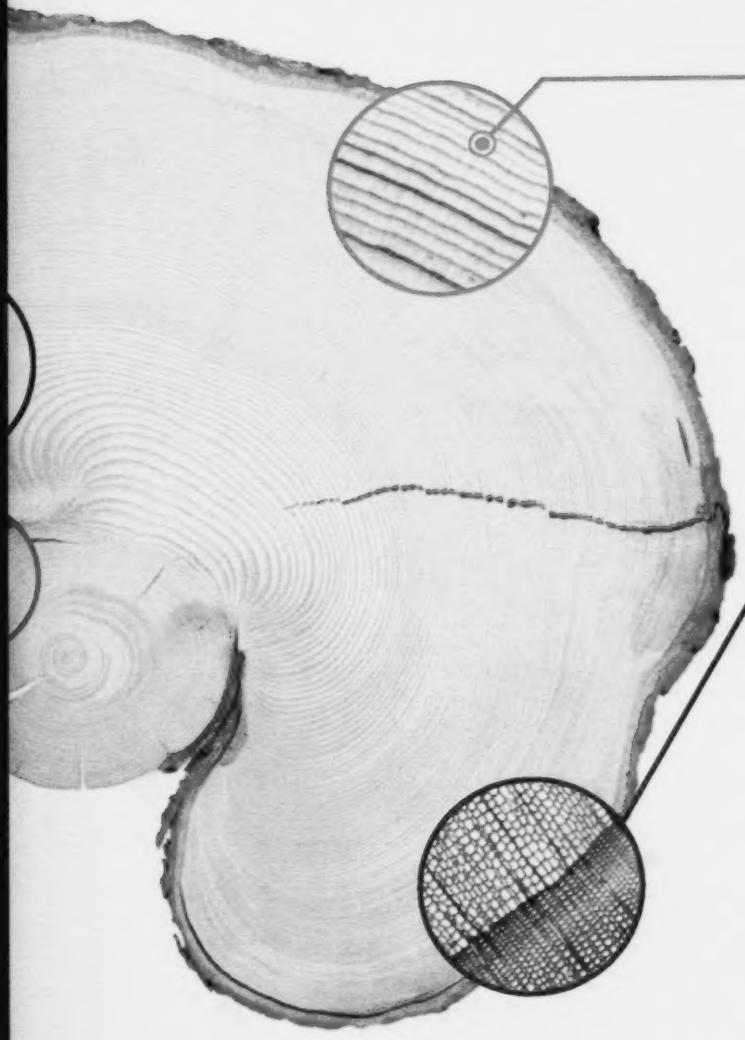
Fire scars occur where a portion of the growing part of the trunk, known as the cambium, is damaged by fire and the tree attempts to cover the wound with new growth. Some fire scars completely heal over, but others remain open (unhealed) due to repeated fires or significant decay of the burned wood – like this one dating back to a fire in 1868, one year after Confederation.

3. Insect outbreaks

Severe or repeated defoliation – the stripping of a tree's leaves or needles – by insects such as the forest tent caterpillar is stressful to the tree and causes a marked slowing of growth that can be seen in the pale annual growth ring on this trembling aspen core. This "white ring" is also of lower density than the wood the tree produced before defoliation and after recovery. Studying the occurrence of white rings in many trees helps scientists better understand the impacts of tent caterpillar outbreaks on aspen forest productivity, how insect populations change over time and how ecosystems respond to outbreaks.



Trees are rarely cut down for tree ring analysis. Instead, a borer is used to extract a core sample of wood, about 3 to 10 millimetres in diameter, extending from the bark to the centre of the tree. This trembling aspen from north of Fort McKay, Alberta, was about 60 years old when sampled in 2006.



4. Climate conditions

Trees with the right amount of sunlight, rainfall and ideal temperatures grow faster and produce wider growth rings than trees under stress. Drought, disease, temperatures that are too hot or too cold and shading or crowding by other trees can slow down tree growth, leaving narrow rings. Studying rings from many trees across the landscape can help scientists understand how the climate may be changing and affecting forest ecosystems over time. The same narrow ring in this tree can be seen in hundreds of other tree samples, suggesting dry soil conditions in the late summer of 1984 across parts of Canada's eastern boreal forest.

5. Wood fibre quality

Wood characteristics like density, sound absorption, strength and stiffness are important qualities that determine the suitability of wood for specific products or end uses, from guitars to engineered wood products and pulp used in packaging and textiles. Microscopic views of tree rings – like this one magnified to 57 times its normal size – can show irregularities in cells caused by water stress or bending due to wind or snow. These irregularities can make wood inflexible, weak or resistant to surface treatment and potentially limit its use for some products. The ability to identify wood fibre qualities of trees before harvest allows forest managers to make better business decisions about what products can be made from the trees growing in a specific forest, and what trees are best suited to plant for future forest products.

Canada's forest sector: Leading the way in the bioeconomy

For a tree coping with drought or a lumber exporter riding the wave of fluctuating markets, the ability to adapt to changing conditions is key to keeping a competitive edge and surviving. Canada's forest industry knows this reality well.

Canada's forest products portfolio is changing

From a legacy that began with firewood, lumber and shipbuilding timber, Canada's forest sector has adapted and reinvented itself time and again to meet the demands of changing and emerging markets. Investments in research and advanced technologies have led to the development of innovative wood, pulp and paper products that are keeping Canada's forest industry competitive, even as markets for traditional forest products fluctuate.

And through the extensive redesign of industry processes, a host of bioproducts are becoming part of this country's forest product mix, too. The production of advanced materials, green chemicals and renewable energy sources is helping Canada break into new product markets. As a result, Canada's forest sector is emerging today as a leading actor in the burgeoning bioeconomy.

Bioproducts provide low- or no-waste alternatives for non-renewable resources

In the bioeconomy, renewable resources such as trees and agricultural crops are being converted into many types of consumer and industrial products. These range from food additives and textiles to construction materials, auto parts, bioplastics, biochemicals and fuel for vehicles and planes.

Bioenergy is already the second largest source of renewable energy (after hydroelectricity) in Canada. In 2000, there were five biomass-powered community heat projects in the country. By 2014, that number had grown to 150 projects.

An advantage of bioproducts is that they provide a way to generate more value from trees while minimizing waste. Even the sawdust and wood chips left over from milling and other forestry processes can be used to create bioproducts. And, when used as a substitute for non-renewable materials and energy sources, bioproducts can help reduce dependence on fossil fuels, cut greenhouse gas emissions and minimize environmental impacts from industrial operations.

This is good news for Canada, whose sustainably managed forests hold a vast supply of renewable wood fibre and other types of forest biomass. Canada's bioeconomy is well supported by a plentiful supply of raw material.

Advanced materials made from wood are used in the construction of mid-rise and tall buildings – 6, 10 and even 18 storeys high.

Bioproducts are hastening Canada's transition to a low-carbon, high-growth economy

As the forest sector's portfolio of bioproducts grows, Canada is gaining a sharp competitive edge in world markets, where modern social and consumer expectations place a high value on clean growth.

Delivering a greater number of bioproducts to market also requires having more highly skilled labour. And that means an increase in well-paying jobs throughout the forest sector and related industries across the country. This is creating new economic opportunities in urban, rural and Indigenous communities. (See Spotlight article: *Indigenous communities and the forest economy*, page 48)

Keeping pace with the bioeconomy depends on continued forest sector innovation and adaptation

Like trees adapt to ever-changing environmental conditions for survival, so the forest sector must continue to innovate and evolve to respond to and anticipate consumer and market demand for new forest products.

Trees are used to make low-calorie sweeteners, clothing, biodegradable plastic, and much more.

This has been the key to the forest industry's survival for more than 150 years.

But the global market potential for bioproducts, estimated at well over $100 billion, looks to be a game-changer. In the new global bioeconomy, Canada's forest sector is poised not just to survive, but to thrive.

A forest of bioproducts is being made from Canadian trees

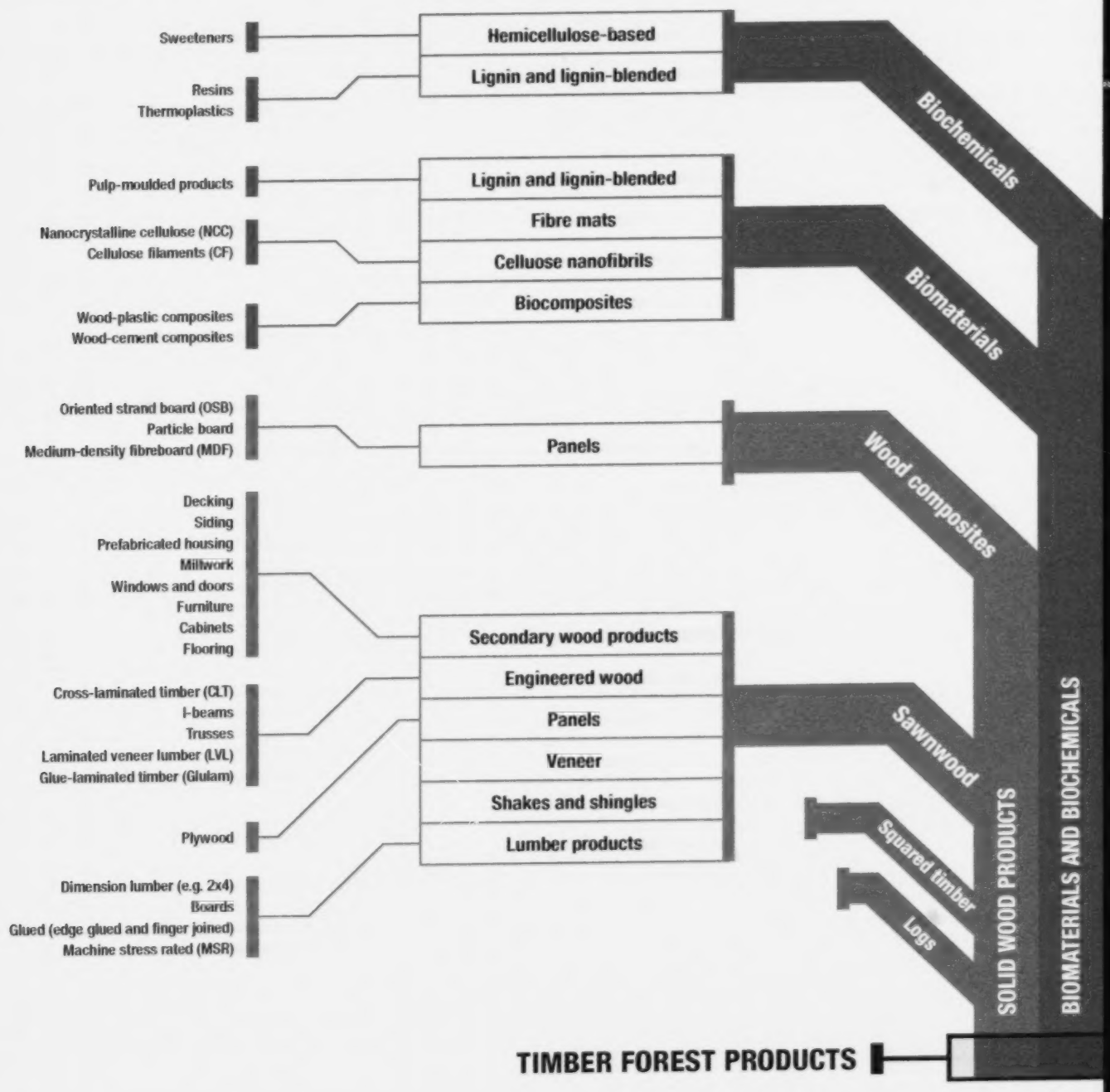
- Renewable biochemicals made from the sugar and lignin converted from wood chips are used to manufacture everyday products such as glues, cleaners, solvents and insulation foam.
- High-value biomaterials derived from wood fibre are used in many energy production and industrial manufacturing processes. For example:
  - ▶ Cellulose nanocrystals are used to make paints, varnishes, LCD electronics, sensors and composites for planes and cars, and to act as carriers for medical drug therapies.
  - ▶ Cellulose filaments are used in composites, packaging, and paper and plastic products.
  - ▶ Biomethanol can be used to make solvents, antifreeze and fuel.
- Research is now underway to expand pulp mills into biorefineries where residues from the pulp-making process can be used to make new bioproducts.

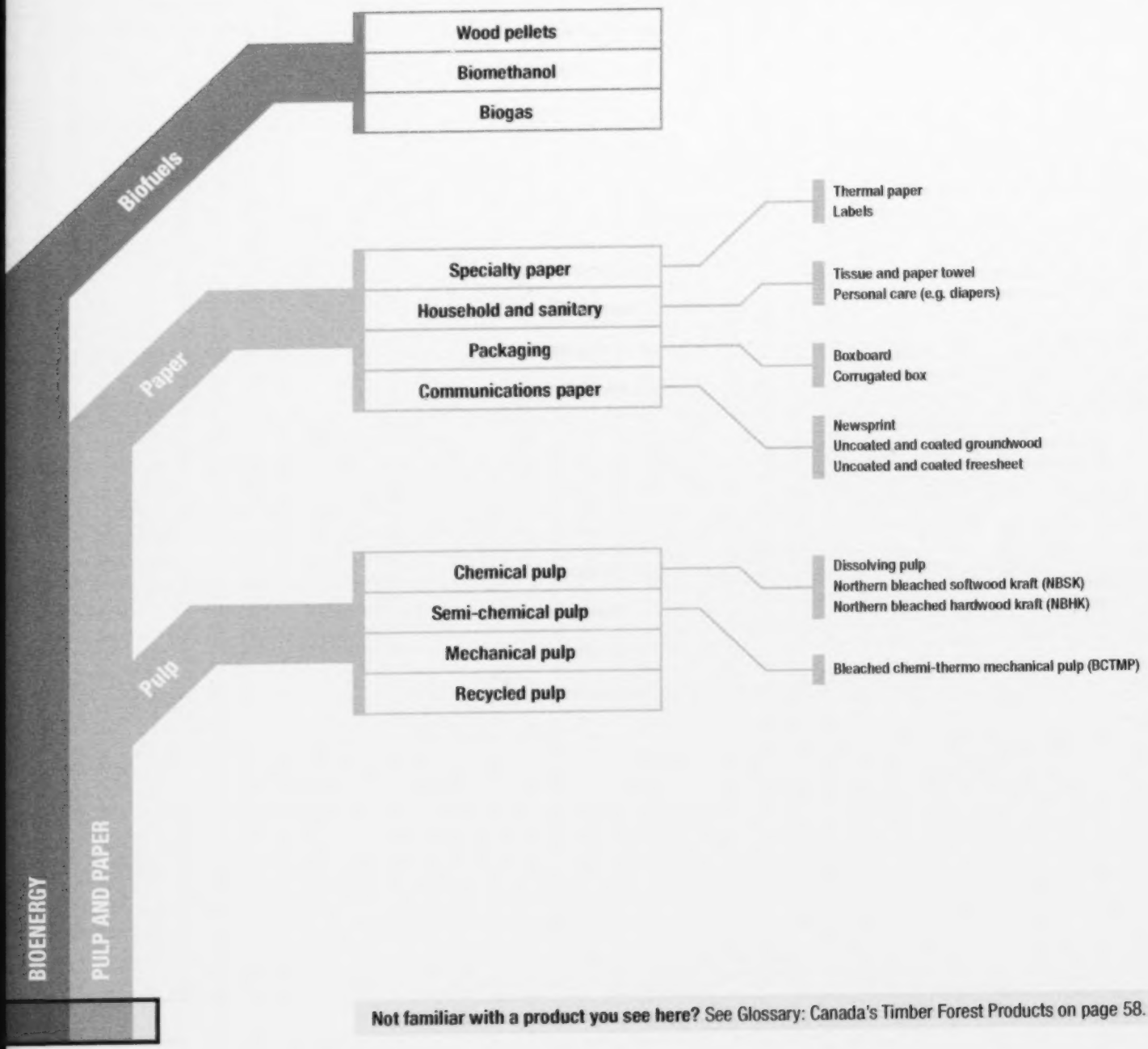
See *Canada's Timber Forest Products* glossary on page 58 for descriptions of these and other bioproducts.

Sources: See *Sources and information* for more detail.

CANADA'S TIMBER FOREST PRODUCTS

Canada's timber forest products have come a long way since the great white pines were harvested pre-Confederation to use as ship masts and squared timber. Through the development of increasingly innovative methods of processing and refining wood, its residues and waste products over time, Canada's forest sector has diversified its range and versatility of timber products to keep a competitive edge. This graphic represents the major groups – but not the entire range – of timber forest products produced in Canada.





Not familiar with a product you see here? See Glossary: Canada's Timber Forest Products on page 58.

Sustainability indicators

Canada's forests are rich ecosystems that provide many renewable resources. They offer significant environmental benefits, social and cultural opportunities, and opportunities for sustainable economic development. Because forests are essential to the well-being of Canada's environment, communities, citizens and economy, Canadians have a deep commitment to sustainably managing this country's forest resources.

Criteria and indicators are a way of measuring progress toward sustainable forest management

Sustainable forest management is a way of using and caring for forests so as to maintain their environmental, social and economic values over time.

Sustainability indicators are helpful tools to provide an overall picture of the state of the forest. These indicators are science-based measures that give government, industry, researchers and the public a way to consistently define, assess, monitor and report progress toward sustainable forest management.

Along with an extensive framework of federal, provincial and territorial laws and regulations, criteria and indicators are a way to help ensure the long-term sustainability of Canada's forests.

When measured over time, indicators show trends that:

- provide essential information for use in discussions about the state of Canada's forests
- highlight where forest management policies and practices may need to be improved
- provide authoritative information to clarify issues related to environmental performance and trade

Canada is a member of the Montréal Process

The Montréal Process is a group of 12 countries, including Canada, that account for 90% of the world's boreal and temperate forests. These countries have developed a common set of science-based indicators to consistently monitor and report on progress toward sustainable forest management.

Federal, provincial and territorial governments cooperate to compile national data

The collection of timely and accurate national data about Canada's forests would not be possible without cooperation among authoritative sources of data, including the provinces and territories.

For example, Canada's National Forest Inventory and National Forestry Database both compile national-scale data to support evidence-based decision-making, scientific research and program delivery through inter-jurisdictional cooperation.

The indicators that follow are presented in a way that addresses the most pressing questions about forests and forestry in Canada. These indicators, together with information in the *Statistical Profiles* section, demonstrate changes in Canada's forests and forest practices over time and are comparable to sustainability indicators published by other countries.

Forests will be a key contributor to progress toward global sustainability goals

In September 2015, the United Nations member states, including Canada, adopted the 2030 Agenda for Sustainable Development. The Agenda includes 17 Sustainable Development Goals (SDGs) and 169 associated targets that aim to improve peace, governance and justice and global sustainable development across social, economic and environmental dimensions.

Forests will be a key part of advancing the United Nations' SDGs.

Forests purify water and air; provide shelter, food, renewable energy, timber and economic development opportunities; and recreational and cultural benefits.

Given that forests cover over 30% of the world's land area and provide a broad range of benefits, improving global sustainable forest management can help advance the SDGs.

Sustainability indicator reporting has never been more important

The global context for international reporting has been shifting quickly with the implementation of the United Nations' SDGs. The importance given to forests in achieving these goals is encouraging, but it also means that measuring and reporting on forests is critical.

Working toward a shared understanding of forest values and harmonized criteria and indicators of sustainable forest management can help measure global progress toward the SDGs. This global cooperation can help ensure a balance among the many demands placed on world forests so current and future generations can reap the economic, environmental and cultural benefits.

Indicators demonstrate the flow of forest benefits in changing circumstances

The sustainability indicators reported in this section provide insight into the interactions between forests and society over time in Canada, while aiming to harmonize with global reporting efforts. These indicators illustrate the complexity of sustainable forest management and the challenges posed by climate change and other emerging issues.

With Canada's many years of experience with sustainable forest management, Canadians can feel confident that forests will continue to be managed to provide a broad range of benefits. Canada's trading partners can be equally confident that the Canadian forest products they receive come from sustainably managed sources.

1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

Sources and additional information for the sustainability indicators are provided starting on page 72.

How much forest does Canada have?

Canada has 9% of the world's forests.

This amounts to 347 million hectares (ha) of forest, of which 270 million ha are boreal forest. This is enough forest to fill all of Cambodia, Cameroon, France, Germany, Italy, Japan, Nicaragua, South Korea, Sweden and Uruguay and still have enough trees left over to fill the United Kingdom.

By volume, Canada's forests contain about 47 billion cubic metres of wood. This is enough timber to cover the City of Montreal in about 36 storeys of solid wood.

How is "forest" defined?

Canada uses the Food and Agriculture Organization of the United Nations definition of forest:

- land spanning more than 0.5 ha
- the tree canopy covers more than 10% of the total land area
- the trees can grow to a height of more than 5 metres

The definition does not include land that is mostly urban or used for agricultural purposes.

A forest that has been harvested is still a forest

Forest land that temporarily has no trees – for example, after harvesting or a natural disturbance such as fire – is still considered a forest, because trees grow back. This is not the same as deforestation, which is the permanent clearing of forest to make way for a new non-forest land use, such as agriculture or commercial development.

The opposite of deforestation is afforestation, which means that new forest is created through planting or seeding on land that wasn't forest before. Afforestation and deforestation drive forest area change.

The current rate of land-use change from forest to other uses is very low in Canada. Between 1990 and 2015, about one-third of a percent of Canada's total forest area was converted to other land uses.

Source: See *Sources and information* for more detail.

Indicator:
Forest area

Canada's forest area of 347 million hectares (ha) has been quite stable over the past 25 years.

- From 1990 to 2015, Canada's forest area has decreased by 1.2 million ha (0.34%).
- The net reduction in forest area over this period is attributed to the clearing of forest land for new, non-forest land uses (for example, agriculture, roads and hydroelectric developments).
- While forest area is relatively constant, forest cover within is much more dynamic. Forest fires, insect infestations, timber harvesting, growth and regeneration contribute to the ever-changing mosaic of forest cover within Canada's forest area.

In previous *State of Canada's Forests* reports, forest area was based on the National Forest Inventory (NFI) baseline survey (period of measurement from 2000 to 2006). Now, to provide trend data and to align with other reporting organizations, forest area is adjusted for known deforestation and afforestation to provide values for other reporting years. The next survey of the NFI is expected to be completed in time for 2020.

Estimated area (millions of hectares) of forest in Canada

	Year					
Area	1990	1995	2000	2005	2010	2015
Forest area	348.3	348.0	347.8	347.6	347.3	347.1

Why is this indicator important?

- Permanent losses and gains in forest area affect the long-term availability of resources, wildlife habitat, biodiversity and ecosystem services such as carbon sequestration and water and air purification.

What is the outlook?

- The overall forest area is expected to remain stable over the next 10 to 20 years.
- Over the longer term, the effects of climate change on growing environments could redraw the boundaries within which forests grow.
- Federal, provincial and territorial governments are collaborating to track changes in forest area using a network of permanent photo plots across Canada. This information, paired with additional data from survey efforts focused on monitoring deforestation, is used to report on forest area and how it is changing over time.

Source: National Forest Inventory. See *Sources and information* for more detail.

Indicator:
Deforestation and afforestation

Canada's very low annual deforestation rate has declined even further over the last 25 years, dropping from 63,100 hectares (ha) in 1990 to about 34,100 ha in 2015.

- Between 1990 and 2015, one-third of a percent of Canada's total forest area was converted to other land uses.
- Some decreases in deforestation are associated with less conversion of forest to agriculture, roads and hydroelectric development.
- Spikes occurred in 1993 and 2006 (dates not shown in table), when 35,000 ha and 28,000 ha of forest, respectively, were flooded during hydroelectric reservoir development.

The National Deforestation Monitoring System provides estimates of changes from forest land to other land uses across Canada. Results are provided by time, region and industry type, allowing trends in forest land conversion to be better recognized and understood.

- Although urban and rural planting initiatives are underway in many regions of Canada, the afforested land area has been very small relative to the total forest area in the country and is therefore no longer tracked.

Estimated area (hectares) of annual deforestation in Canada, by industrial sector, 1990–2015

	Year					
Sector	1990	1995	2000	2005	2010	2015
Agriculture	42,100	22,300	20,500	18,000	12,300	12,300
Forestry*	3,700	3,300	3,600	3,400	1,400	1,400
Hydroelectric	2,700	1,500	900	800	1,900	900
Mining	2,800	2,700	2,900	3,000	3,600	3,200
Oil and gas	4,400	5,400	7,900	11,100	9,900	9,800
Transportation	2,000	1,700	3,000	2,800	2,600	1,900
Industry	900	900	900	1,000	1,200	1,200
Municipal	3,900	3,700	4,300	4,600	3,200	3,200
Recreation	600	700	700	600	300	300
Total	**63,100**	**42,000**	**44,600**	**45,400**	**36,300**	**34,100**

*Forestry numbers result from the creation of permanent forestry access roads.

Why is this indicator important?

- Shrinking forest cover has the potential to reduce biodiversity, affect soil and water quality, and impact wildlife habitat.
- Forests also provide an important means of storing carbon, which influences climate change.

What is the outlook?

- Canada's overall deforestation rate is expected to decline further over time.
- Deforestation resulting from activity in Canada's oil and gas sector has increased since 1990, but conversion of forest to agricultural land uses will likely remain the largest cause of deforestation in Canada. These conversions are small relative to the overall size of Canada's forests.

Source: National Deforestation Monitoring System, National Forest Inventory. See *Sources and information* for more detail.

Indicator:
Wood volume

Canada's forests contain about 47 billion cubic metres (m^3) of wood.

- The Boreal Shield ecozone contains almost one-third of Canada's total wood volume, with more than 15 million m^3 of wood.
- Although the Boreal Shield has more forest land and wood volume than any other ecozone in Canada, these forests are relatively slow growing, producing an average wood volume of 118 m^3 per hectare (ha).

Wood volume includes the volume of all forest stands regardless of age class, ownership, protection status and whether the stand is managed for timber.

- The Pacific Maritime ecozone includes Canada's most productive forest land, with an average wood volume of 432 m^3/ha, more than triple the national average of 136 m^3/ha.

Wood volume on forest land by terrestrial ecozone

Ecozone	Wood volume (millions of cubic metres)
Pacific Maritime	4,636
Montane Cordillera	7,815
Boreal Cordillera	2,315
Taiga Cordillera	869
Taiga Plains	5,201
Boreal Plains	5,180
Prairies	290
Taiga Shield	2,815
Boreal Shield	15,470
Hudson Plains	353
Mixedwood Plains	423
Atlantic Maritime	1,953
Canada (total)	47,320

Why is this indicator important?

- Wood volume provides basic information about the amount of standing wood in Canada's forests.
- Wood volume is used by professional foresters to determine sustainable harvest levels in stands being managed for timber production.

What is the outlook?

- Overall wood volume in Canada's forest area is a balance of the gains from forest growth and regeneration offset by the losses from human-caused disturbances (such as harvesting) and natural disturbances (such as forest fires, insect infestations and diseases).
- Because of the complex interactions of climate change on tree growth, the calculation of long-term wood volume is more nuanced and complex.
- Federal, provincial and territorial governments are collaborating to track changes in tree growth and wood volume, using a network of permanent sample plots across Canada.

Source: National Forest Inventory. See *Sources and information* for more detail.

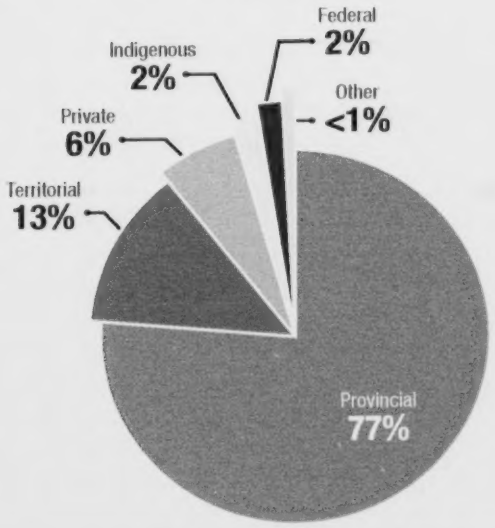
Is timber being harvested sustainably?

Canada's sustainable forest management regime ensures that our forests remain healthy and continue to provide a steady stream of benefits for Canadians. With strong laws, oversight and management, timber harvesting in Canada is sustainable.

Most of Canada's forests are publicly owned

About 90% of Canada's forests, by area, are located on provincial and territorial Crown lands. Forest management on these lands falls under the purview of provincial and territorial governments.

Forest ownership in Canada



In 2015, about 161 million cubic metres (m^3) of industrial roundwood were harvested in Canada. This is equal to approximately 0.3% (47 billion m^3) of Canada's total standing wood volume.

British Columbia accounted for nearly half (42%) of Canada's industrial roundwood harvest, followed by Alberta and Quebec.

Forest management planning is a key sustainability tool

Forest management planning is one of the primary tools used to ensure that Canada's publicly owned forests remain socially, economically and environmentally sustainable. Forestry companies operating on Crown lands must, by law, draw up a forest management plan in consultation with the public and have it approved by a provincial or territorial government before any harvesting can begin on Crown land. Forest management plans outline access plans, harvesting, regeneration and other standards that must be followed. Forestry practices are subject to ongoing monitoring to ensure the plans are followed.

Provinces and territories regulate harvest levels in forest management plans

To ensure forest sustainability over the long term, provincial and territorial governments regulate harvest levels through forest management plans. This is done by specifying an allowable annual cut (AAC): the annual level of harvest allowed on a particular area of Crown land over a set number of years (5 to 10 years in most cases).

Regeneration is required after harvesting

All Crown lands that are harvested for commercial timber must be regenerated naturally, by planting and seeding, or by using a combination of these methods. Each province and territory has its own regeneration standards and regulations, addressing such factors as species composition, density and stocking levels. These standards are also addressed in forest management plans.

Natural regeneration offers many benefits. For example, it needs little human assistance, and it generally costs less to do than artificial regeneration (through planting and/or seeding). But the latter may be needed to accelerate the regeneration process and ensure that government regeneration standards are met.

Sources: See *Sources and information* for more detail.

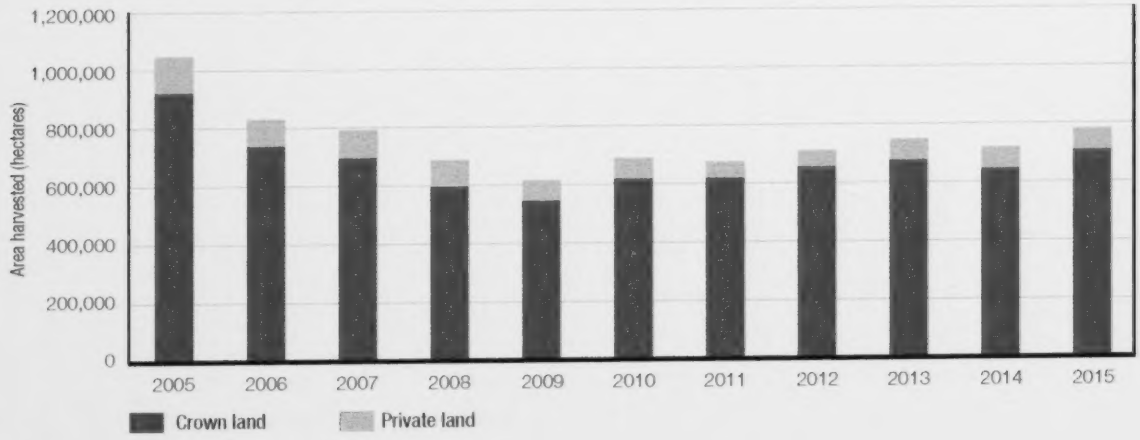
Indicator:
Area harvested

The area of forest harvested each year is monitored to ensure that the level of industrial activity in Canada's forests is sustainable over the long term. In 2015, an estimated 780,000 hectares (ha) of forest were harvested.

- This is a 9% increase over 2014 levels, when 714,000 ha were harvested. This is well below the average area harvested of about 1 million ha per year during the peak period of 1995 to 2005.
- Most of the increase was due to a rise in the area of public land harvested, although the area of private land harvested also increased.

The area harvested each year is less than one-half of one percent of Canada's 347 million hectares of forest, significantly smaller than the areas damaged by insects and burned by fires each year.

Forest area harvested on private and Crown lands in Canada, 2005–2015



Why is this indicator important?

- Commercial timber harvesting is one of several indicators of the level of industrial activity in the forest sector.
- Harvesting of forests on Crown land, the source of most commercial timber, is regulated to provide a sustainable level of wood supply.

What is the outlook?

- The area harvested will vary as the demand for Canadian forest products varies and forest managers adjust their management objectives.
- The demand for Canadian wood products is expected to increase over the short term as U.S. housing starts rise and offshore exports, particularly to Asia, remain strong.
- The area of forest harvested, however, is not expected to rise above pre-recession levels.

Source: National Forestry Database. See *Sources and information* for more detail.

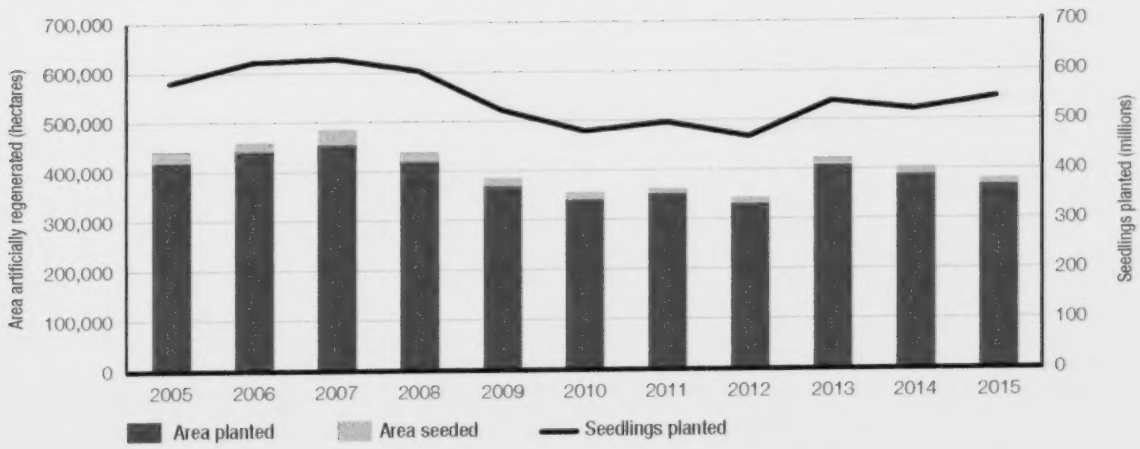
Indicator:
Regeneration

In 2015, 543 million seedlings were planted on 370,000 hectares (ha) of provincial forest lands in Canada. Seeding was used to re-establish forests on an additional 7,900 ha.

- The number of seedlings planted has remained relatively stable since 2013 and is within 1% of the 10-year average.
- For the past six years, seeding has accounted for less than 4% of the area artificially regenerated.
- Most regeneration activities occur on harvested lands, so steady rates of regeneration reflect stable harvest levels.

Successful regeneration is required following forest harvesting on Crown lands. Regeneration may be achieved through natural or artificial (planting or seeding) means. The type of forest, type of harvesting method and desired composition of the new forest determine the regeneration method.

Area artificially regenerated and number of seedlings planted on provincial Crown lands in Canada, 2005–2015



Why is this indicator important?

- Regeneration activities ensure that harvested areas regrow as forests continue to produce timber and maintain ecosystem services, such as storing carbon, regulating water quality and providing habitat.
- How forests are regenerated can influence forest composition over time.

What is the outlook?

- Regeneration is required on all Crown lands in Canada, so virtually all harvested lands will continue to be regenerated.
- The area regenerated is related primarily to recent harvest levels, which are influenced by market conditions for wood products.
- The proportions of natural and artificial regeneration are unlikely to deviate from recent trends.

Source: National Forestry Database. See *Sources and information* for more detail.

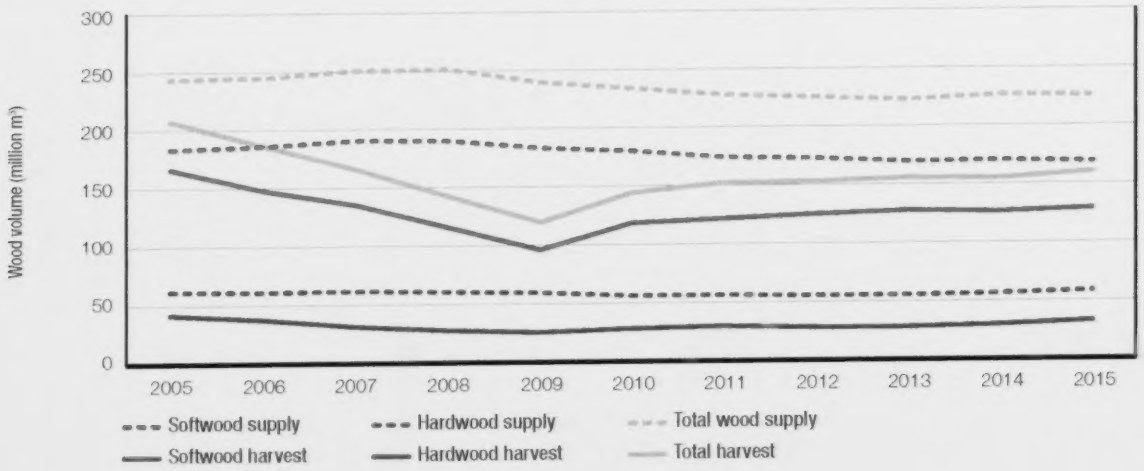
Indicator:
Volume harvested relative to the sustainable wood supply

In 2015, Canada harvested just over 160 million cubic metres (m^3) of timber, well below the estimated sustainable wood supply level of 226 million m^3.

- This is an increase of about 5 million m^3 from 2014 levels, when 155 million m^3 of timber were harvested.
- This is due to an increase in the volume of both softwood and hardwood timber harvested.
- There was virtually no change in the estimated volume of wood supply deemed to be sustainable.

Sustainable wood supply refers to the volume of timber that can be harvested from provincial, territorial, private and federal lands while meeting environmental, economic and social objectives.

Annual harvest versus supply deemed sustainable for harvest, 2005–2015



Why is this indicator important?

- Forest managers track the volumes of timber harvested each year to ensure they fall within sustainable levels.
- Harvests from provincial Crown lands are regulated by allowable annual cuts (AAC).
- While there is no AAC calculated for Canada as a whole, it is possible to compare the combined provincial AACs with the combined timber harvest totals from the same Crown landbase.

What is the outlook?

- As the global demand for Canadian forest products increases, the volume of timber harvested can be expected to increase, narrowing the gap between harvest and sustainable wood supply levels.
- Yet, harvest levels are expected to remain below the sustainable wood supply, given the strong provincial and territorial regulatory regimes in place.

Source: National Forestry Database. See *Sources and information* for more detail.

How does disturbance shape Canada's forests?

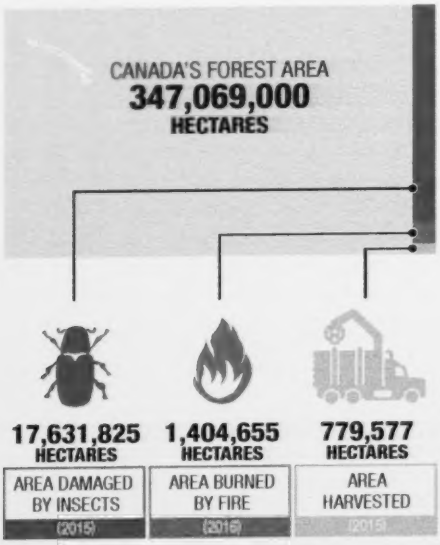
Fire, insects and disease constantly affect Canada's forests. They renew whole forest landscapes and shape forest composition, structure and habitat diversity over time.

These natural disturbances – and others such as drought, floods and wind storms – vary in severity, extent and frequency, and their relative importance varies from region to region and over time. The result is that Canada's forests are all part of a dynamic landscape, one that has always been in a constant state of change.

Natural disturbances bring forest renewal

Natural disturbances such as fire, insect outbreaks and disease are an important part of the natural life cycle of forests, especially Canada's boreal forests.

Fire is a key agent of change and renewal in the boreal zone, releasing nutrients, allowing sunlight to reach the forest floor and releasing the seeds of some species from their cones. (See *Why Canada's forests need fires* on page 12.)



Natural disturbances, the forces of change in Canada's forests, are themselves being affected by climate change.

For example, climate change is expected to increase drought in some forest areas, which will in turn make forests more susceptible to insects, diseases and forest fires.

Diseases and large insect outbreaks sometimes result in extensive stand mortality. This process releases nutrients from decaying trees and reduces competition among surviving and newly establishing trees, enabling forest renewal and succession. However, forests are less well adapted to exotic insects and diseases introduced through global trade, so these outbreaks can have negative rather than positive impacts.

Disturbances can have negative effects

While natural disturbances are essential to forest health and renewal, they can have a negative impact on the people, communities and businesses that reside in or rely on forests, at least in the short term. In addition to threatening human safety, property and infrastructure, natural disturbances can damage and reduce the supply of timber and so affect socio-economic well-being of communities and citizens. (See *Learning to live with forest fires* on page 14.)

Disturbances affect the carbon cycle

Forests play an important role in the carbon cycle, absorbing carbon as they grow and releasing it when they die and decay or burn in fires. Whether they absorb or release more carbon each year depends on many complex factors, including the impacts of natural disturbances, especially fire.

Sources: See *Sources and information* for more detail.

Indicator:
Forest diseases

Tree diseases can be detrimental to stand productivity, largely by affecting the rate of growth or mortality in the forest.

- The environment plays a critical role in the disease process, as environmental conditions may directly influence disease, affect the ability of a pathogen to spread and infect hosts, or influence host susceptibility to pathogens.
- In addition to native forest pathogens, exotic pathogens have become established in Canada. One such pathogen, *Cronartium ribicola*, the causal agent of white pine blister rust, has had a major impact on five-needle pines in Canada since its introduction at the beginning of the 20th century.

Why is this indicator important?

- Diseases can result in a range of impacts, from volume loss to decreased wood quality and ultimately tree mortality.
- In a commercial forestry context, when the primary objective is the production of high-quality forest products, impacts of disease are considered negative.
- In a forest managed for biodiversity and conservation, forest disease can be viewed as an agent of nutrient cycling and habitat creation.

A lodgepole pine killed by Armillaria root disease.

Sources: See *Sources and information* for more detail.

Diseases include a wide range of infections caused by bacteria, viruses and other microorganisms (called *pathogens*, collectively), as well as abnormalities and disturbances to the normal structure and growth of a tree.

Tree disease symptoms usually develop as a result of complex relationships between susceptible trees, environmental conditions and pathogens. They can affect all parts of a tree including its roots, stems and foliage.

Trees stressed by adverse environmental conditions can become more susceptible to pathogen impacts as a result of their reduced ability to mount a defence response.

What is the outlook?

- Climate change will affect both hosts and pathogens. However, predicting exactly how host and pathogen interactions will change is difficult. Managers will need to monitor forests carefully in order to respond rapidly to changes in forest pathogens.
- The root disease pathogen *Armillaria ostoyae* is expected to cause increased mortality in trees already affected by drought conditions induced by climate change.
- Regulations developed in response to past pathogen introductions are an important element in the strategy to reduce future damage from exotic pathogens.

Indicator:
Forest insects

In 2015, 17.6 million hectares (ha) of forest were damaged by insects in Canada.

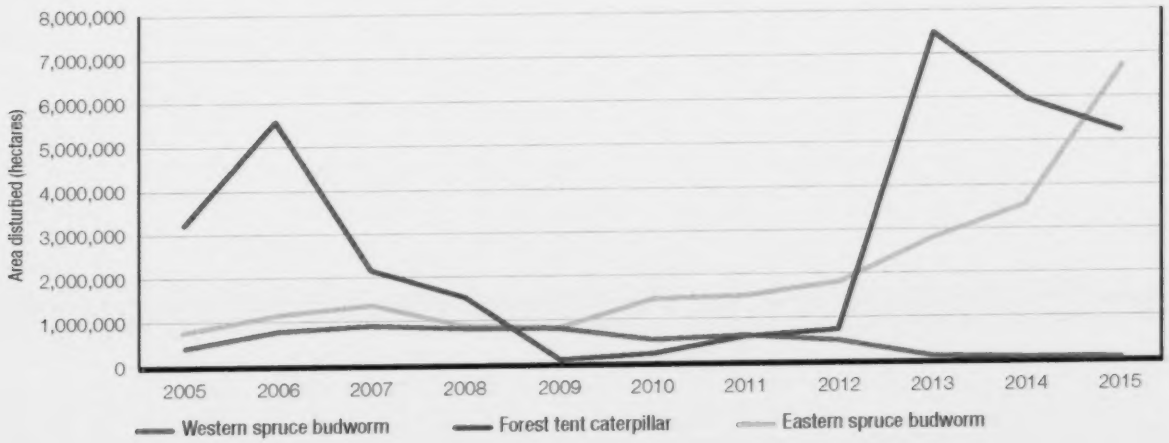
- This was a 13% decrease in area damaged from the previous year.
- Large increases in the size of the spruce budworm outbreak in Quebec were more than offset by decreases in the area affected by aspen defoliators in Alberta and British Columbia.
- The area affected by bark beetles continued to decrease overall.

Defoliating insects can both weaken and kill healthy trees, while bark beetles often attack trees already under stress. Monitoring trends in both insect groups allows researchers and forest managers to gauge the impact of insects on wood supply and forest health.

Defoliating insects

- In 2015, the spruce budworm epidemic continued to grow, nearly doubling in extent to 6.7 million ha.
- In the same year, forest tent caterpillar populations and a suite of other aspen defoliators declined significantly in western Canada.

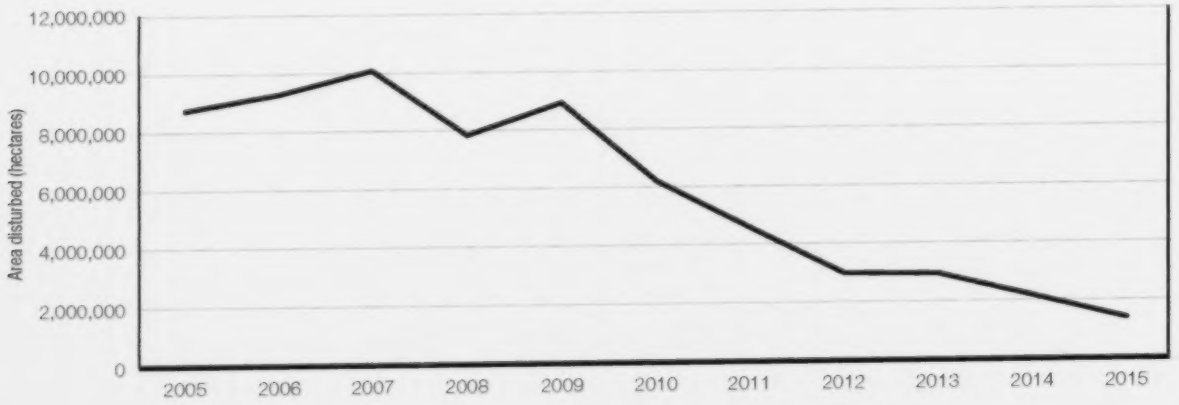
Forest area containing defoliated trees for three insects in Canada, 2005–2015



Bark beetles

- Mountain pine beetle populations in British Columbia continue to decline.
- The distribution of mountain pine beetle in Alberta's pine forest continues to be extensive. Populations are fluctuating regionally, and beetles are continuing to spread slowly eastward.
- Populations of balsam bark beetle and spruce beetle are relatively high in British Columbia, with 2.3 million ha of balsam bark beetle and 194,000 ha of spruce beetle mapped in 2015.

Forest area affected by mountain pine beetle in British Columbia, 2005–2015



Why is this indicator important?

- Insects are one of the most important agents of disturbance in Canada's forests.
- Their feeding can either kill trees directly or seriously reduce trees' health and productivity.
- Because insect populations are sensitive to both average and extreme temperatures, they are important indicators of climate change in forest ecosystems.

What is the outlook?

- The spruce budworm outbreak in Quebec is expected to continue increasing and spreading into additional areas in Ontario, New Brunswick and the rest of Atlantic Canada.
- Mountain pine beetle continues to increase in Alberta, and its eastward spread into Saskatchewan and beyond remains a concern.
- The spruce beetle outbreak in British Columbia is expected to continue increasing in both extent and severity.

Source: National Forestry Database. See *Sources and information* for more detail.

Spotlight:
Citizen scientists and the eastern spruce budworm outbreak

Scientists are calling on citizens to help track a major insect outbreak in eastern Canada's fir and spruce forests.

Eastern spruce budworm is a native insect that is always present in our forests. Every 30 to 40 years, large outbreaks occur and can last for years, affecting millions of hectares.

By stripping and eating the tree needles (defoliating the tree), spruce budworm damages and eventually kills trees. This affects the economic, recreational and aesthetic values of the forest, impacting communities, the forest industry and the people who rely on this sector for their livelihood.

Spruce budworm: A major pest

Spruce budworm is the main defoliator of conifers (trees with needles) in Canada's forests. In early spring, larvae (caterpillars) emerge from hibernation and eat the young needles on the trees. Around midsummer, the larvae become pupae, from which adult moths emerge about 10 to 12 days later. The moths then mate, lay eggs and sometimes move to new stands of trees.

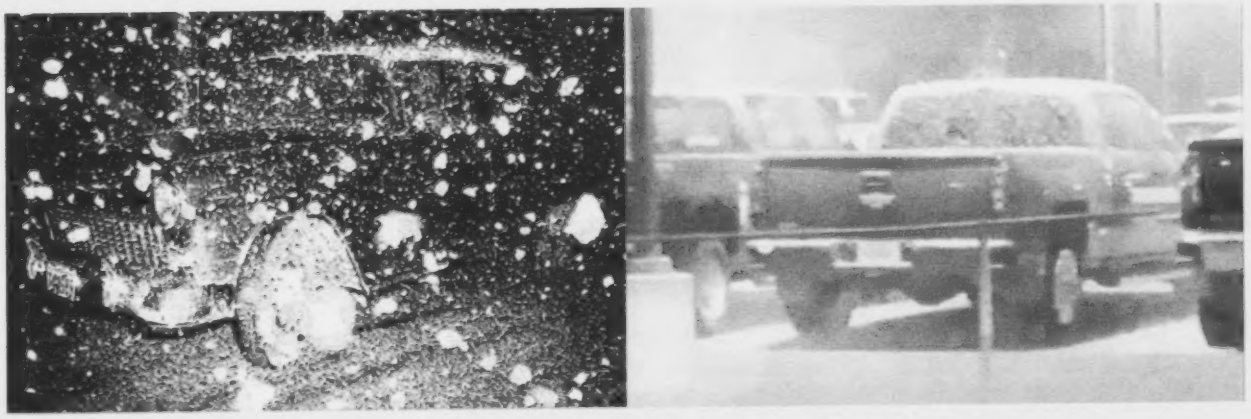
Outbreaks of spruce budworm tend to be widespread and severe. The outbreak that ended in 1993 affected 52 million hectares (ha) in eastern Canada and the U.S. The current outbreak, which began in Quebec in 2006, had affected 7 million ha by 2015.

Insect outbreaks are an important natural disturbance in Canada's forests. Some affect small areas and have limited impact. In these cases, forest managers may let the outbreak run its course. However, when large outbreaks have the potential to affect millions of hectares of forest and cause extensive damage, forest managers may look for ways to control the spread and limit the impact of the outbreak.

Tracking large outbreaks poses large challenges

Scientists are doing research to better understand spruce budworm ecology and options for managing outbreaks. For example, an early intervention strategy for New Brunswick is aiming to protect forests where communities live, work and play. Early intervention involves keeping budworm populations low by knocking down "hot spots" (areas with rising populations), slowing the spread of the insect and helping protect forests from the severe defoliation that a major outbreak would cause.

Scientists monitor populations of spruce budworm using traps that contain the insect's sex pheromone, the chemical that the females emit to attract mates. By setting traps and then counting the number of budworm



Spruce budworm outbreaks are cyclical: flights of moths in 1957 and 2016 in Campbellton, New Brunswick.

moths that fly into them, the scientists can learn more about where, how and how quickly the outbreak is spreading. This also helps them identify the "hot spots" that may need to be treated.

But monitoring a large outbreak covering vast areas is challenging. This is where citizen science comes in.

Citizen scientists gather data for researchers

Used in a growing range of fields, from biology and medicine to astronomy, citizen science involves volunteers gathering data to help scientists answer research questions.

In the case of the spruce budworm outbreak, an innovative project called Budworm Tracker is giving volunteers in eastern Canada the tools to gather and report data on spruce budworm populations – data that is helping scientists monitor and better understand the insect and its spread.

In this initiative, volunteers receive a free Budworm Tracker kit containing a pheromone trap, a data collection sheet and detailed instructions. They hang their trap from a lower branch of a spruce or balsam fir tree near where they live or work.

Locations of Budworm Tracker traps.

Budworm Tracker 2016: By the numbers

- Number of traps sent to volunteers: 405
- Number of volunteers who submitted data: 352
- Return rate: 87%
- Moths collected: over 16,000
- Total days of data collected: 5,328

A young citizen scientist checks a Budworm Tracker pheromone trap for spruce budworm moths.

From mid-June until the end of the summer, these citizen scientists check the trap at least once a week, collecting and counting the moths and recording their findings. Volunteers with a smartphone can report their findings directly on the Budworm Tracker website or use a downloadable app. At the end of the summer, the volunteers mail the data sheet and the moths back to the researchers, who validate and analyze the data.

In this way, citizen scientists are giving researchers data on population numbers and on the timing, conditions and patterns of moth flights. Follow-up DNA analysis of the moths by the scientists also provides information about where the moths are coming from – in other words, how they spread.

By participating and contributing to real, on-the-ground research, citizens involved in Budworm Tracker are learning about both science and their environment. In the future, this model of citizen science could be used for research on other insect pests – an exciting prospect for citizens and scientists alike.

Sources: See *Sources and information* for more detail.

Indicator:
Forest fires

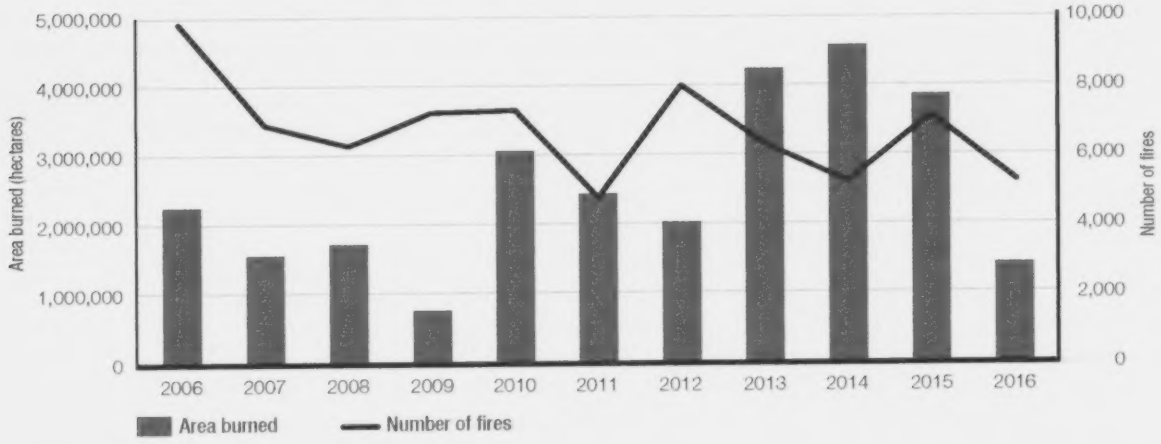
In 2016, Canada experienced 5,243 forest fires, with approximately 1.4 million hectares (ha) burned, well below the average for both the number of fires and area burned.

- On average, since 1990, Canada has about 7,500 fires a year, burning 2.4 million ha. In 2015, however, Canada had 7,140 fires that burned 3.9 million ha, the third year in a row of above-average area burned.
- Last year's shift from an El Niño to a La Niña state in the Pacific Ocean brought rain and cool weather for western Canada, which led to an early end to the fire season.

Forest fires are a natural part of the forest ecosystem and are important in many parts of Canada for maintaining the health and diversity of the forest. However, they may also be harmful and can threaten communities directly or with smoke, resulting in public health and safety concerns and costly economic and environmental losses.

- Extremely large fires with severe consequences – such as the fire that burned in Fort McMurray, Alberta, in 2016 – can happen in Canada even in years when fire occurrence is below average for the nation.

Forest area burned and number of forest fires in Canada, 2006–2016



Why is this indicator important?

- When and where significant fire activity occurs can vary greatly from year to year, though fire trend analysis indicates that fire seasons are starting earlier and lasting longer.
- Information on trends in the fire situation across the country helps researchers assess both the health of Canada's forests and the effects of the changing climate on them.

What is the outlook?

- The frequency and severity of forest fires in Canada will likely increase as climate change brings about warmer temperatures and less rainfall.
- The increased frequency and severity of fires may affect the cost of fire management and result in greater impacts on people and communities, such as evacuations and loss of homes.

Source: National Forestry Database; Canadian Interagency Forest Fire Centre. See *Sources and information* for more detail.

Indicator:
Forest carbon emissions and removals

In 2015, total net emissions of carbon dioxide equivalent (CO_2e) from Canada's *managed forest* (see sidebar) were about 221 million tonnes (Mt).

Total net emissions are calculated by adding emissions/removals caused by human activities to emissions/removals caused by large-scale natural disturbances in Canada's managed forest.

Human activities in Canada's managed forest accounted for removals of about 26 Mt CO_2e in 2015, while large-scale natural disturbances accounted for emissions of about 247 Mt CO_2e in 2015. In this way, the 247 Mt CO_2e emissions minus the 26 Mt CO_2e removals equals the 221 Mt CO_2e net emissions.

In Canada's managed forest:

- Forest lands managed for timber production continue to be an ongoing sink (absorber) of carbon (26 Mt CO_2e in 2015).
- The area that burned in the managed forest in 2015 was over 2 million hectares (ha), nearly double the area burned in 2014. This resulted in higher emissions from natural disturbances than in previous years.
- The impacts of the mountain pine beetle in British Columbia continued to decline.

Canada's 2017 National Inventory Report, 1990–2015 (from which these results are derived) has implemented a new approach for estimating and reporting on emissions and removals resulting from human activities in the managed forest. For more information about these changes, see the textbox *A new approach to reporting*.

Why is this indicator important?

- Carbon as carbon dioxide (CO_2) in the atmosphere is an important contributor to global warming.
- Canada's forest sector contributes to both emissions and removals of CO_2 from the atmosphere.
- Natural disturbances, mostly outside the control of humans, significantly impact the ability of Canada's managed forests to consistently absorb more CO_2 than they emit.

As a party to the United Nations Framework Convention on Climate Change (UNFCCC), Canada must report annually on greenhouse gas (GHG) emissions from the *managed forest*.

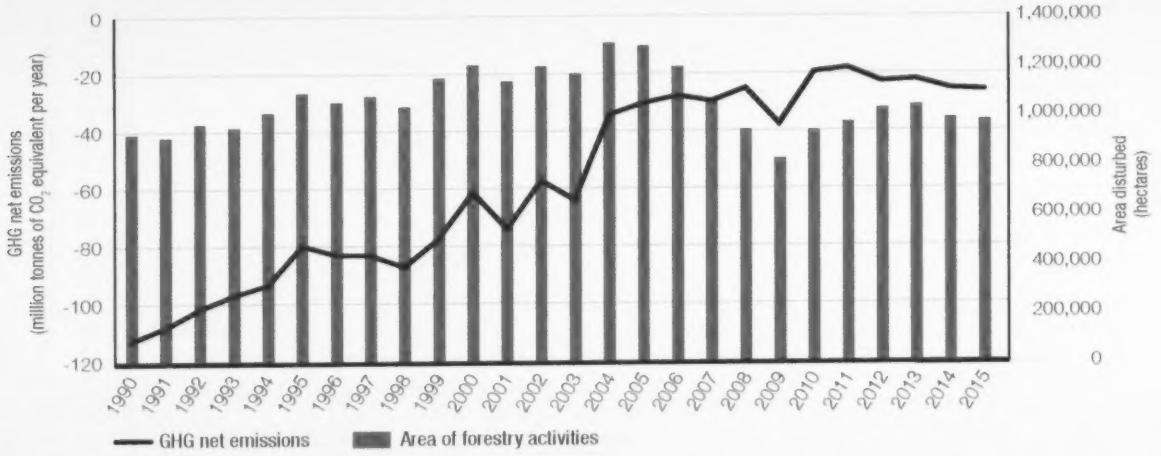
The *managed forest* is made up of all forests under direct human influence. It's a subset of Canada's total forest area and includes forests managed for harvesting, forests subject to fire or insect management, and protected forests such as those found in national and provincial parks.

For greenhouse gas reporting, the managed forest area in Canada is about 226 million hectares, or 65% of Canada's total forest area. All other forests in Canada are considered to be *unmanaged*.

The data in this indicator are consistent with UNFCCC reporting. More information about definitions and methods can be found in Canada's 2017 *National Inventory Report, 1990–2015*.

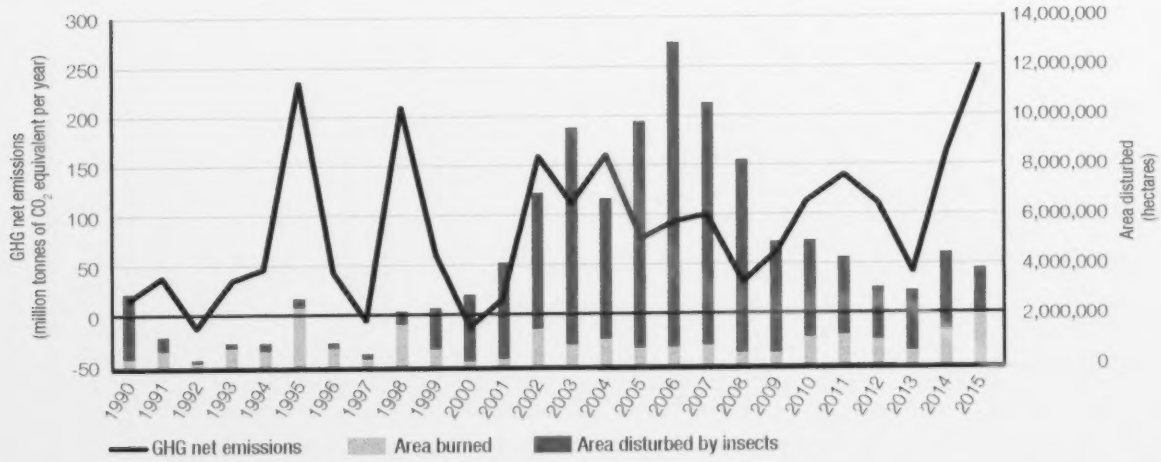
- Changes in forest management and the use of harvested wood products can help mitigate the impacts of climate change.

Net carbon emissions in Canada's managed forest: Areas subject to human activities, 1990–2015



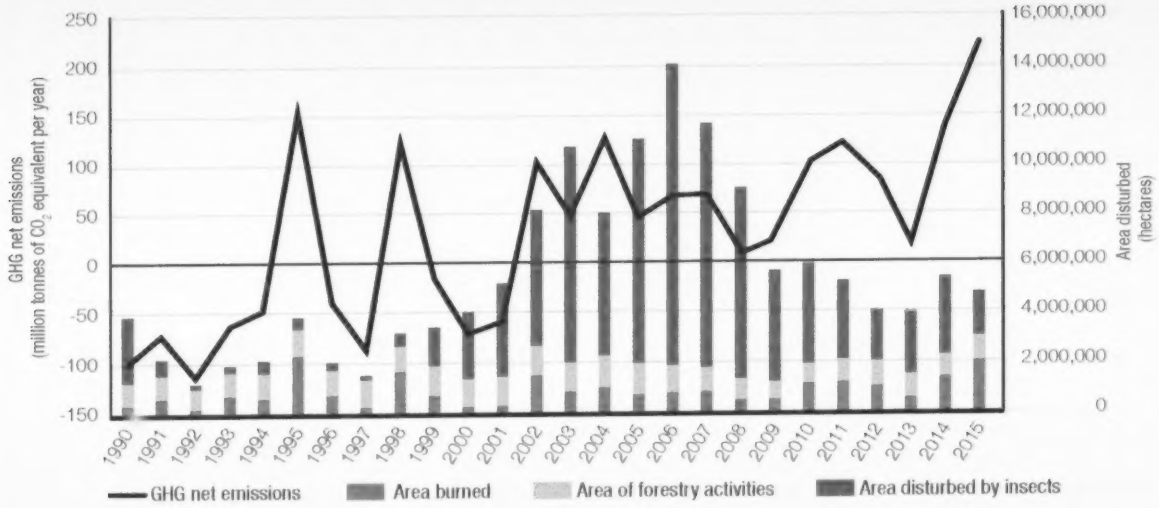
In 2015, forest management activities in Canada's managed forest, such as harvesting and regeneration, as well as the use and disposal of harvested wood products created a net sink of about 26 Mt CO_2e.

Net carbon emissions in Canada's managed forest: Areas subject to natural disturbances, 1990–2015



Natural disturbances in Canada's managed forest resulted in emissions of about 247 Mt CO_2e in 2015. This was mainly due to forest fires burning nearly 2 million hectares, the largest area burned in Canada's managed forest since 1995.

Net carbon emissions in Canada's managed forest: All areas, 1990–2015



The total net emissions and removals from Canada's managed forest sector, taking into account both human activities and natural disturbances, totalled about 221 Mt CO_2e in 2015.

What is the outlook?

- The impacts of climate change on Canada's forest GHG balance are challenging to predict with certainty. Regionally, some could be positive (for example, enhanced forest growth and therefore greater carbon sinks) and some negative (for example, higher tree mortality or more forest fires or insect outbreaks).
- Increased use of long-lived wood products to store carbon in the built environment, and use of wood products instead of materials that are emissions-intensive to make – such as concrete, steel and fossil fuels – provide climate change mitigation opportunities.

A new approach to reporting

Canada's National Forest Carbon Monitoring, Accounting and Reporting System provides annual estimates of the greenhouse gas balance for Canada's managed forests. These estimates of emissions and removals are reported every year in Canada's *National Inventory Report* to the United Nations Framework Convention on Climate Change (UNFCCC).

In previous years, estimates of carbon emissions and removals from Canada's managed forest displayed large year-over-year variability because natural disturbances, especially forest fires, masked the subtler impacts of human forest management activities.

To this end, the Intergovernmental Panel on Climate Change (IPCC) recommended that countries develop new approaches to separate emissions and removals caused by human activities from emissions and removals caused by natural disturbances. This makes it possible to detect trends in emissions attributable to forest management.

This new methodology enhances Canada's ability to monitor and report on the consequences of forest sector climate change mitigation efforts. Details of the new approach, including definitions and methods, are provided in sections 2.3.4.1 and 6.3.1.2 of Canada's *2017 National Inventory Report, 1990–2015.*

Source: Natural Resources Canada–Canadian Forest Service calculations; Environment and Climate Change Canada, *2017 National Inventory Report, 1990–2015: Greenhouse gas sources and sinks in Canada*. See *Sources and information* for more detail.

How do forests benefit Canadians?

Forests provide a wide range of economic, environmental and social benefits to both individual Canadians and the communities in which they live.

Forests provide economic opportunities

The forest industry creates economic benefits through jobs and income across the country. These are especially important in rural and Indigenous communities.

In 2016, the industry accounted for 211,075 direct jobs – for foresters, scientists, engineers, computer technologists, technicians and skilled tradespeople – and an estimated 95,000 indirect jobs in related activities. In rural areas, these jobs are crucial to ensuring the economic sustainability of communities, with the benefits trickling down through entire local economies.

Forests provide ecosystem services and other environmental benefits

Forests provide many essential ecosystem services. They preserve soils, cycle nutrients and support biodiversity. They act as natural cleansers, filtering pollutants from air and water. In cities and other urban areas, tree cover in parks and on boulevards helps to reduce surface and air temperatures and improve air and water quality.

Forests also play a key role in the carbon cycle, the constant movement of carbon from the land and water to the atmosphere and living organisms. By absorbing and storing carbon – such as that emitted by human activities like burning fossil fuels – forests help to maintain the global carbon balance and to moderate the effects of climate change.

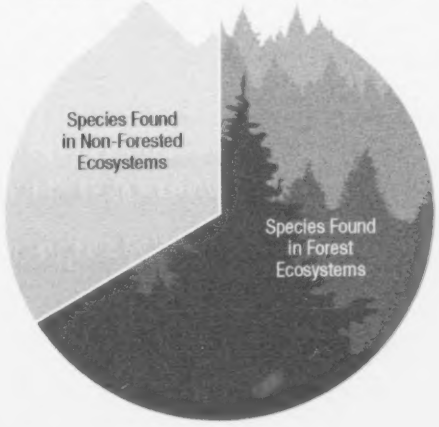
Canadians benefit economically from a number of forest products in addition to timber. Non-timber forest products include forest-based foods, such as maple syrup, blueberries, mushrooms and game meat, which make a significant economic contribution in many rural communities.

Forests provide social and cultural benefits

In addition to providing recreational and ecotourism opportunities, forests have cultural, aesthetic and spiritual importance for people living in both urban and rural areas.

Although their social benefits are hard to measure, forests are deeply valued and enjoyed by the 11 million Canadians living in or near forested areas across the country as well as by those who live in urban areas.

Of the estimated
140,000 SPECIES
found in Canada
about 2/3rd are found in forest ecosystems



Sources: See *Sources and information* for more detail.

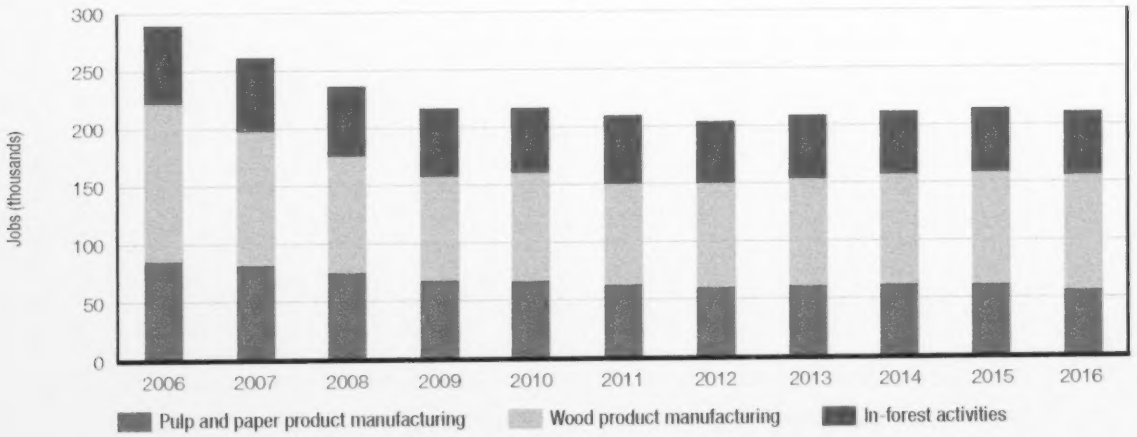
Indicator:
Employment

Employment has remained largely stable since 2011. Total direct employment in the Canadian forest industry decreased slightly in 2016 to 211,075 jobs (a decline of 1.1%), following three years of slight increases.

- Employment in pulp and paper manufacturing continued to decline as demand for paper products falls.
- Employment in forestry and wood product manufacturing increased overall, as demand rose from the U.S. housing market.
- In the Prairie provinces, employment in forestry and wood product manufacturing fell because of the Fort McMurray forest fire and slowing economic activity in the region from low oil prices.

The total number of jobs should always be considered alongside wages and other indicators. With advances in technology, fewer workers are required to produce the same level of output, but those jobs tend to be higher skilled and higher paid. (See *Indicator: Average Earnings*, on page 46.)

Forest industry direct employment, 2006–2016



Why is this indicator important?

- The Canadian forest industry is an important employer nationwide and contributes to the economic and social welfare of all Canadians.
- Forestry's contribution is particularly important in many rural and Indigenous communities, where forest-related work is often the main source of income.

What is the outlook?

- Over the long term, forest industry employment is expected to remain stable, with losses in pulp and paper manufacturing being balanced by gains in other sectors.
- The ongoing softwood lumber dispute with the U.S. has the potential to negatively impact forestry employment across Canada in the short term.

Sources: Statistics Canada, System of National Accounts. See *Sources and information* for more detail.

Indicator:
Average earnings

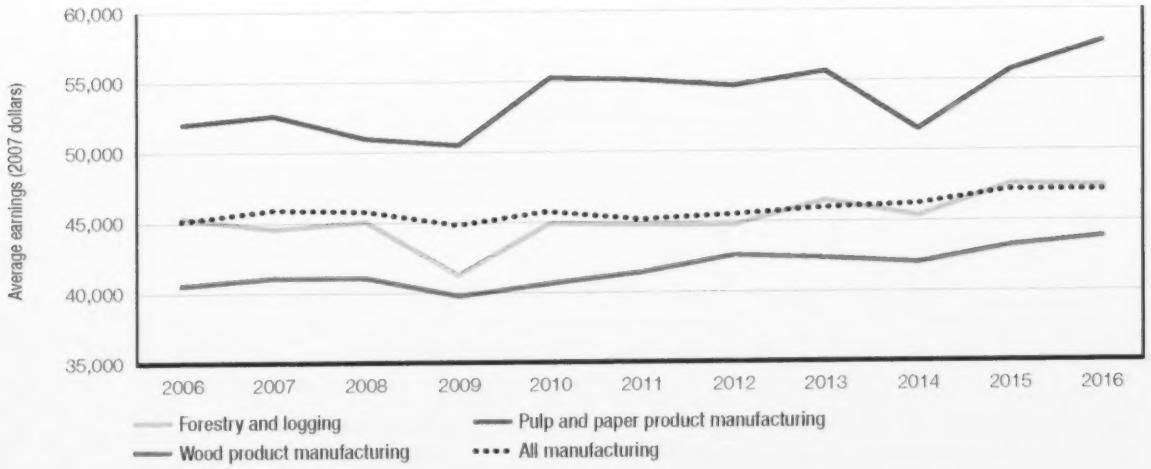
In 2016, average earnings in the forest industry increased by 2% over 2015 levels.

- Wages have been largely stable in forestry and logging activities and in wood product manufacturing over the past couple of years.
- Wages in pulp and paper manufacturing have increased markedly since 2014. In 2016, average earnings for a pulp and paper employee reached close to $67,000, a 5% year-over-year growth.
- The upward trend in pulp and paper manufacturing can be attributed to both the closure of less efficient operations and the addition of new, higher-value product lines.

Average earnings refers to the average net annual income per person directly employed in the forest industry, not including overtime pay.

- The growth in average earnings after inflation in the forest industry remains higher than in the overall manufacturing sector, which was flat between 2015 and 2016.

Average earnings in the forest industry compared with all manufacturing sectors, 2006–2016



Why is this indicator important?

- Trends in forest industry average earnings indicate the importance of the industry to the economy and to the social well-being of Canadians, especially when compared with average earnings in other industries.
- Real wage growth (meaning wage growth that isn't the result of inflation) shows the change in actual purchasing power of forest industry employees.

What is the outlook?

- Average earnings in the forest industry are expected to continue rising despite declines in total employment in some segments, such as pulp and paper.
- Ongoing research and development activities in the bioeconomy are expected to result in the need for more highly skilled, highly paid employees.

Source: Statistics Canada, System of National Accounts. See *Sources and information* for more detail.

Indicator: Communities

The forest sector is an important part of the lives of many Canadians. In addition to employment and income, it provides recreational, cultural, traditional and spiritual benefits.

- About 33% of Canadians live in or adjacent to forested areas.
- The forest sector is a major source of income in 171 census subdivisions in Canada.*
- About 9,700 Indigenous people worked in the forest sector in 2016, which makes it one of the largest employers of Indigenous people in the country.

Forest proximity, forest sector income and forest sector Indigenous employment across Canada are just some of the indicators that together portray how forests influence the lives and communities of Canadians.

Why is this indicator important?

- In communities with a large proportion of workers and revenue linked to the forest sector, social and economic well-being are highly dependent on the economic strength of the sector.
- Residents in forest-based areas also benefit from a range of environmental services (clean air and water, erosion protection, wildlife habitat) and from opportunities for outdoor recreation. These benefits enhance human health by improving physical, mental and spiritual well-being and reducing stress.

What is the outlook?

- Regions that depend heavily on the forest sector suffered during the economic downturn in the past decade, but the industry is now recovering.
- New and diversified opportunities are becoming available across Canada, including in the development of non-traditional products such as bioenergy, bioplastics and green chemicals.
- The forest sector is expected to continue being important in the coming decades to many Canadians, not just those living in forested, remote and Indigenous communities but also those in urban areas as the industry comes to play a greater role in Canada's transition to a green, low-carbon economy.

* Municipalities or areas that are deemed to be equivalent to a municipality for statistical reporting purposes.

Source: Statistics Canada, System of National Accounts. See *Sources and information* for more detail.

Spotlight:
Indigenous communities and the forest economy

The forest sector transformation underway in Canada over the last two decades hasn't been limited to making changes in technology, products and markets. These changes are also improving Indigenous peoples' access to forest resources and increasing their control over decisions about how forests are used, harvested and managed.

About 70% of Indigenous people in Canada live in or near forests.

The forest sector is one of the largest employers of Indigenous people in Canada.

About 9,700 Indigenous people are employed in the forest sector.

Land claim settlements, modern treaties and inclusive forest management practices are all creating opportunities to meaningfully advance the process of reconciliation with Indigenous peoples in this country.

Today, forest businesses and economic development organizations owned and run by Indigenous people are finding new ways to work with forest companies, provincial and territorial governments, forest research institutes and non-profit organizations. The aim of collaborative training, education and knowledge sharing is to achieve economic benefits while also ensuring the sustainable management of forests.

Through joint-venture projects across Canada based on mutual respect and cooperation, Indigenous communities and individuals are trailblazing with innovative approaches to forest research, land use planning, harvest decision-making, product development and market access. These projects are not only creating long-term economic and community development opportunities, but also safeguarding culturally, spiritually and biologically important ecosystems.

Using traditional knowledge of non-timber forest products to meet new market demands

Global consumer interest in buying locally produced foods and naturally sourced health products has recently spawned another major trend: foraged foods. Demand for forest greens, berries and mushrooms and other fungi is boosting sales of non-timber forest products.

Since 2014, the Timiskaming, Abitibiwinni and Lac Simon First Nations in Quebec's Abitibi-Témiscamingue region have been researching the economic and market potential of a dozen non-timber forest products. And soon these three Algonquin First Nations hope to be giving consumers a range of such products from the boreal forest.

Chanterelle mushrooms are not commercially cultivated and only grow in the wild.

Market research results are promising, especially for the food, aromatic and natural health product sectors. The main customer base is in Ontario, Quèbec, the United States and Europe. More field tests and market research are underway, and community members, including youth, are being trained as harvesters. The communities are also planning to build a processing plant and create a business for selling and distributing local products.

The benefits of this initiative are expected to go far beyond jobs and revenues. The harvesting of non-timber products will give younger community members the chance to gain important traditional knowledge from Elders.

Using wood waste to enrich soils and local economies

The densely forested region of Quebec's Saguenay–Lac-Saint-Jean region is home to about a dozen sawmills. Sales of sawn logs have long been profitable, but the mills' main waste product, wood chips, has had little commercial value. This situation, however, is changing fast.

Biochar helps soil retain nutrients and water and store carbon longer than uncharred organic matter.

Chips and other wood residues are now being made into biocoal, a new family of products with many potential applications.

One of these products, biochar, is a carbon-rich material that can be used to amend and remediate contaminated soils and to enhance soils on organic farms. Testing of biochar shows reductions in water and fertilizer use and in overall maintenance costs of treated areas, which suggests the market for biochar is lucrative.

Biocoal is created by heating wood biomass, such as wood chips, without oxygen. Depending on the level of heat applied, different products result, ranging from carbon-neutral coal to soil treatment materials and purifiers for water, gas and gold.

Since 2012, the Filière forestière des Premières Nations du Québec (FFPNQ) has assessed various aspects of the production of biochar and biochar byproducts. Positive findings prompted the creation of BioChar Borealis in 2015–2016, a joint venture between the Pekuakamiulnuatsh Takuhikan First Nation of Mashteuiatsh and the regional county municipality of Domaine-du-Roy.

In 2017, the Government of Canada and the Government of Quebec announced their support for a biochar and biochar by-product production project in the Pekuakamiulnuatsh Takuhikan community. The community is working with the Agrinova college technology transfer centre associated with the Collège d'Alma to acquire specialized equipment to turn biomass, including sawmilling residues, into biochar.

Every successful forestry venture, like the examples featured above, is creating a positive environment for other new forest initiatives to grow and guiding meaningful progress along the path to reconciliation with Indigenous communities across Canada.

Sources: See *Sources and information* for more detail.

How does the forest industry contribute to Canada's economy?

The forest industry is one of Canada's most important manufacturing sectors. In 2016, it:

- accounted for about 7% of Canada's total exports
- injected roughly $23 billion into Canada's economy
- directly supported about 211,075 jobs across the country, including an estimated 9,700 Indigenous people
- generated more than $1 billion in revenue (2015) for provincial and territorial governments

What is the forest industry?

Traditional forest products are the backbone of the Canadian forest industry. These include lumber and other solid wood products, and pulp and paper. The forest industry also includes upstream activities, such as forest management and logging. However, non-traditional forest products (for example, advanced bioproducts) are growing in prominence, especially given Canada's commitment to clean technology and a transition to a low-carbon economy. (See *Canada's Timber Forest Products* infographic, page 22).

An economic engine for communities coast to coast

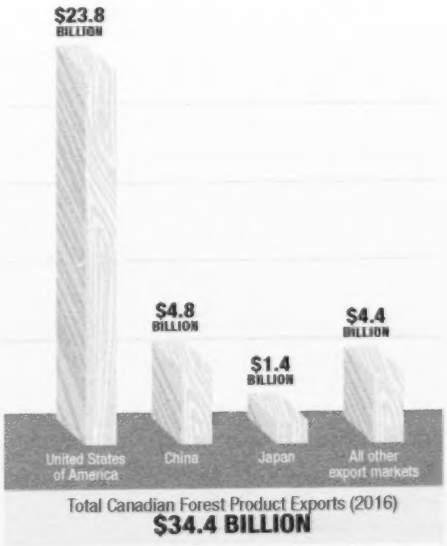
Forest operations are located in all regions of Canada except the far north:

- Over 50% of forest industry jobs are located in Ontario and Quebec.
- About 38% of forest industry jobs are located in the Prairie provinces and British Columbia, with the vast majority being in British Columbia.
- A little under 10% of forest industry jobs are located in Atlantic Canada.

While the Canadian forest industry is a major employer nationwide, its economic contributions are particularly important in many rural and Indigenous communities, where forest-related work is often the main source of income and crucial to ensuring their economic sustainability.

The forest industry's largest export markets

Globalization is increasing trade possibilities beyond Canadian producers' traditional markets. The U.S. market has long been the main importer of Canadian forest products. However, the hard impact of the U.S. housing crash and worldwide financial crisis spurred Canadian producers to expand to other markets. Exports to Asian markets, mainly China, have risen sharply over the past decade and helped mitigate the negative effects of the U.S. downturn.



Sources: See *Sources and information* for more detail.

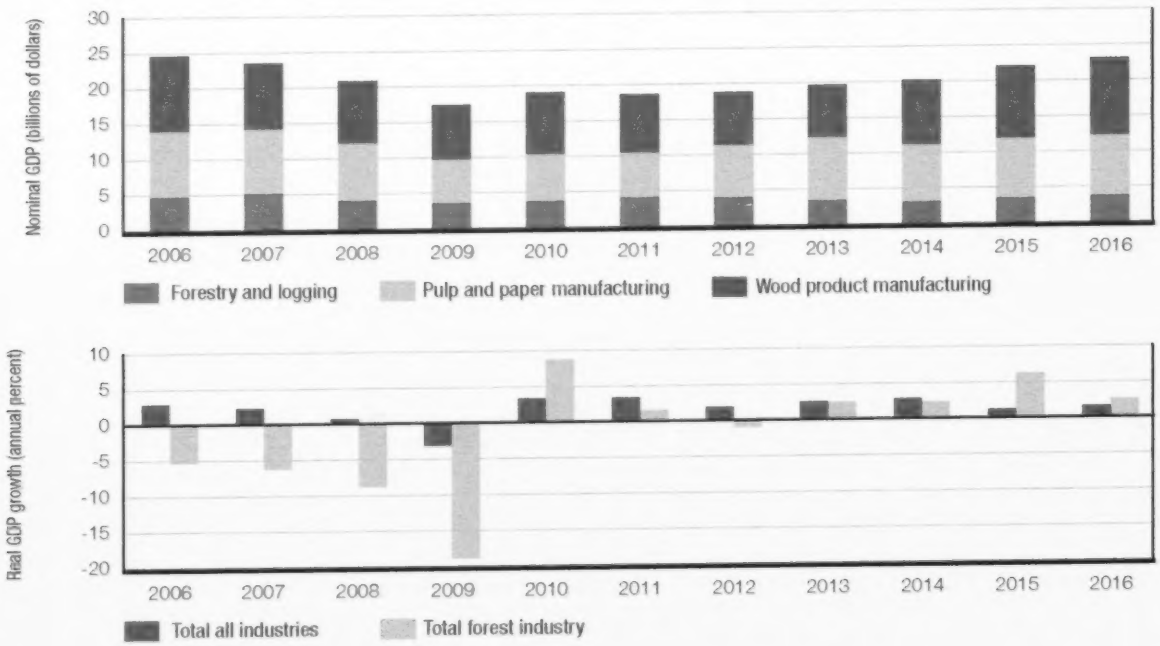
Indicator:
Gross domestic product

The forest industry contributed over $23.1 billion (1.2%) to Canada's nominal GDP in 2016.

- The forest industry outperformed the overall Canadian economy in 2016, growing by 2.4% from 2015 while the Canadian economy grew by 1.4%.
- Wood product manufacturing, which accounts for almost half of forest industry GDP, grew by over 6% (real GDP) from 2015 to 2016.

Gross domestic product (GDP) is the total value of all final goods and services produced annually in a country. It can be thought of as the size of a country's economy.

Canadian forest industry's GDP, 2006–2016



Why is this indicator important?

- Contribution to nominal GDP is one of the primary indicators used to gauge the size and health of Canada's forest industry compared with the size and health of other economic sectors in a financial year.
- The change in real GDP shows the growth of the forest industry after inflation is factored out: real year-over-year growth. Real GDP allows analysts to gauge the trend of the Canadian forest industry's contribution to the economy.

What is the outlook?

- In the short term, the strong U.S. economy and housing market are expected to continue driving GDP growth in Canada's forest industry, although this growth could be negatively impacted by the ongoing Canada–U.S. softwood lumber dispute.
- Over the long term, fibre supply constraints and an ongoing decline in newsprint and paper demand are expected to be offset by growth in solid wood manufacturing.

Sources: Statistics Canada and Natural Resources Canada. See *Sources and information* for more detail.

Indicator: Production

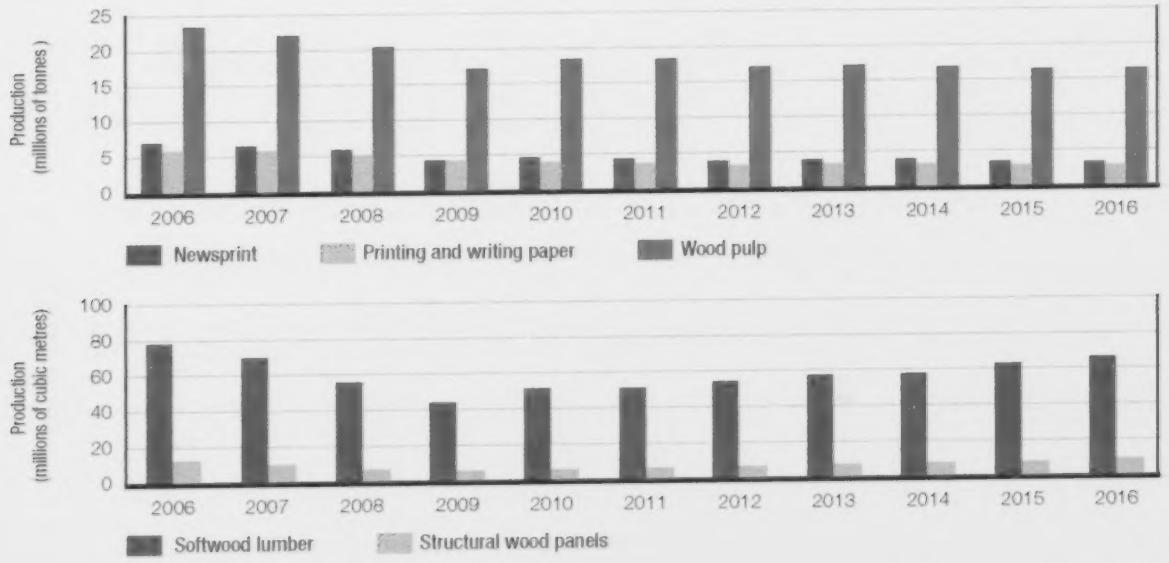
In 2016, Canadian production of solid wood products saw strong growth thanks to rising U.S. demand, while production of pulp and paper continued to decline.

- Production of softwood lumber increased by 6.2% and production of structural panels increased by 9.6% in 2016 over 2015 levels. This is the highest level of production for these two products since 2008, though still below historical peaks.

Canada is the world's largest producer of newsprint, the largest producer of northern bleached softwood kraft pulp and the second-largest producer of softwood lumber.

- Newsprint production fell by 4%, and production of printing and writing papers and of wood pulp showed small declines, 1.4% and 0.3%, respectively.

Production of Canadian forest products, 2006–2016



Why is this indicator important?

- Canada is one of the top manufacturers of forest products in the world.
- Production is one of the first indicators to respond to economic and market challenges.

What is the outlook?

- In the short term, fibre supply constraints and the ongoing Canada–U.S. softwood lumber dispute will likely negatively impact the production of softwood lumber and, to a lesser degree, of structural panels.
- Production of engineered wood products is expected to be positive, although this segment is still very small overall.
- Production of paper products will continue to vary, with growth in consumer segments (tissue paper and packaging) partially offsetting further declines in newsprint and printing and writing paper.
- Production of wood pulp is expected to remain stable, as robust demand overseas offsets decreasing domestic consumption.

Sources: Lumber – Statistic Canada; panel – APA, the Engineered Wood Association; pulp and paper products – Pulp and Paper Products Council. See *Sources and information* for more detail.

Indicator:
Exports

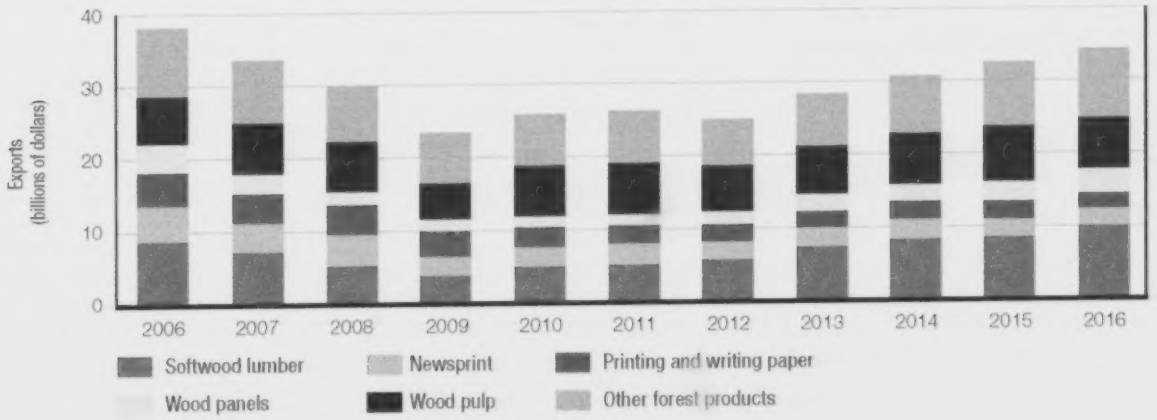
Canada's total forest products exports have grown once again, with export values rising in 2016 above 2015 values as the U.S. housing market continues its post-recession recovery.

- Canada's forest products exports overall increased by 5.3% in 2016, reaching $34.4 billion from $32.6 billion in 2015.
- Softwood lumber exports rose by 17.4% from 2015 (to $9.97 billion in 2016), and wood panel exports increased by 21.6% (to $3.3 billion).

By value, Canada is the fourth-largest forest product exporter in the world, behind U.S., China and Germany, and the leading exporter of softwood lumber and newsprint.

- Wood pulp exports fell by 6.1% from 2015 (to $7.2 billion in 2016), newsprint fell by 5.6% (to $2.2 billion), and printing and writing paper fell by 12.3% (to $2.2 billion).

Exports of Canadian forest products, 2006–2016



Why is this indicator important?

- As one of the world's largest forest products exporters, Canada is a key supplier to nations around the globe.
- Canada has an abundant and renewable supply of wood that is sustainably managed. By exporting forest products, the Canadian forest industry meets the needs of consumers around the world while contributing substantially to Canada's economy and balance of trade.

What is the outlook?

- Newsprint and printing and writing paper exports are in a long-term decline as a result of the fast-growing electronic media era. However, a weak Canadian dollar continues to support forest product exporters in other segments, especially in the U.S. market.

Sources: Statistics Canada. See *Sources and information* for more detail.

How is the forest industry changing?

Canada's forest industry is undergoing major changes as global demand for traditional forest products shifts and demand for non-traditional products grows.

The market for newsprint and printing and writing paper continues to shrink as more consumers turn to digital media in place of print media. As well, another Canada–U.S. softwood lumber dispute is causing uncertainty in lumber markets.

At the same time, new applications for existing products, along with development of innovative products, are helping the forest sector adjust to changes in market needs, improve financial performance and demonstrate a commitment to sustainable forest management.

For example, next-generation building systems are expanding Canada's traditional line of structural lumber products. New wood-based materials and building design systems are boosting demand for wood products in construction applications in both existing and emerging markets.

New markets and new challenges are creating a new industry structure

In the forest industry, as in other industries, the growth of multinational firms and the expansion of trade have led to increased global integration. Because many Canadian firms have acquired assets in the U.S. in recent years, the forest industry's structure has changed from being made up of Canadian companies in North American markets to being made up of North American companies in global markets.

Bioproducts, including biochemicals, biomaterials and bioenergy, are made from biomass, including the wood-fibre residues and byproducts of forest product manufacturing.

Bioproducts are a fast-growing category of forest products. Biochemicals, for instance, are being used to make pharmaceuticals, biodegradable plastics, personal care products and industrial chemicals. (See *Canada's forest sector: Leading the way in the bioeconomy* on page 20.)

New technologies are improving environmental performance and energy efficiency

Investment in new technologies is also changing forest industry operations. For example, between 2004 and 2014, Canada's forest industry cut its total energy use by 35% and reduced its direct carbon emissions by 49% by generating bioenergy from waste products, increasing energy efficiency and reducing energy use. Research is now underway to expand pulp mills into biorefineries where residues from the pulp-making process can be used to make new bioproducts.

Sources: See *Sources and information* for more detail.

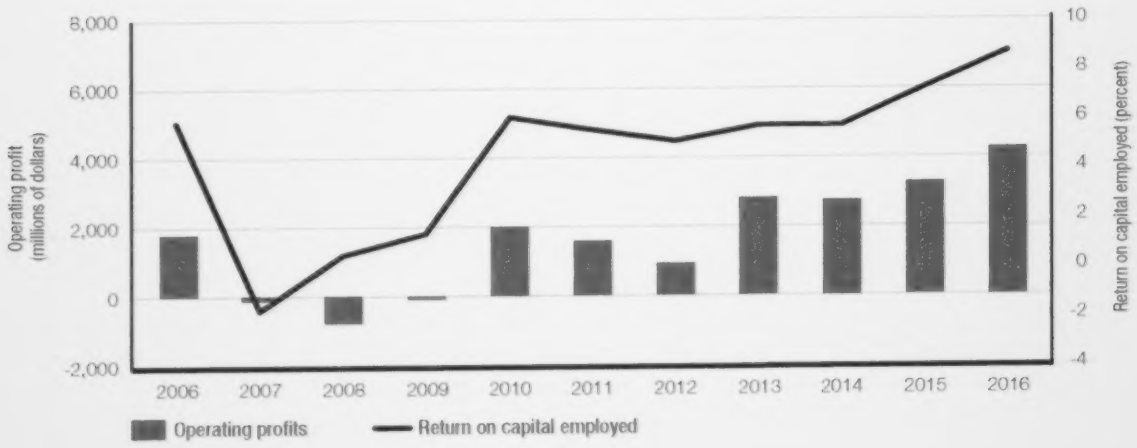
Indicator:
Financial performance

The financial performance of Canada's forest industry improved in 2016. This was largely the result of demand growth in wood markets that pushed up prices, together with a weaker Canada–U.S. exchange rate that helped all forest product exporters.

- Operating profits in 2016 rose by 31.3% from 2015 levels.
- Return on capital employed increased to 8.6% in 2016 (up from 7.1% in 2015), its highest level since 2009.

Both operating profits and the return on capital employed indicate the economic competitiveness of the forest sector. *Operating profit* measures the difference between operating revenues and operating expenses. *Return on capital employed* measures the efficiency of capital use in the industry.

Financial performance by Canada's forest industry, 2006–2016



Why is this indicator important?

- Strong financial performance is essential for the continued economic competitiveness of Canada's forest industry.
- Both operating profits and return on capital employed help show whether Canada's forest sector can attract investment and continue to generate economic activity.

What is the outlook?

- Continued weakness in the Canadian dollar is expected to benefit the competitiveness of Canada's forest sector through increased exports.
- High operating profits will allow firms to make investments such as improving the efficiency of operations.
- Decline in demand is expected to dampen revenue prospects in the printing and writing paper sub-sector, while an improving U.S. housing market looks positive for solid wood and panel producers.

Source: Statistics Canada. Quarterly financial statistics for enterprises. See *Sources and information* for more detail.

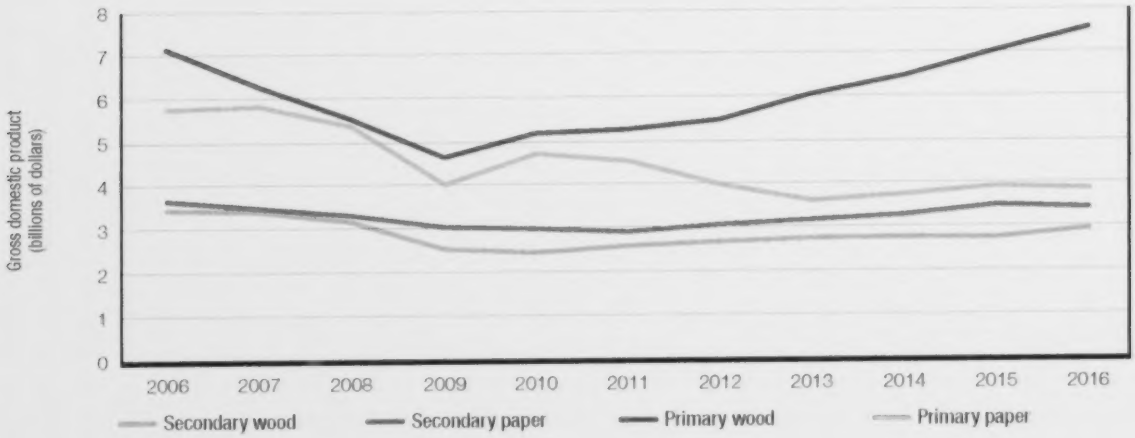
Indicator:
Secondary manufacturing

In 2016, the secondary wood and paper product industries in Canada generated over $6.3 billion in real gross domestic product (GDP). This was a 2% increase from 2015 but still 11% less than 2006.

- Secondary wood manufacturing increased by 7% in 2016 from 2015, while secondary paper manufacturing fell by 2%.
- Secondary manufacturing accounted for 36% of the total contribution of forest product manufacturing to GDP in 2016, the same as in 2015.

Secondary wood and paper product manufacturing uses lumber and paper to make intermediate and final products such as doors and envelopes.

Gross domestic product from primary and secondary wood and paper product industries, 2006–2016



Why is this indicator important?

- Secondary manufacturing of forest products generates additional employment and revenue, which in turn increases the overall contribution that the forest industry makes to the Canadian economy.
- Secondary manufacturing, being geared mainly to domestic markets that tend to be more stable than the primary products geared to international demand, helps balance out changes in world markets.

What is the outlook?

- Demand is expected to be stable for secondary paper products, given the steady growth of the North American economy.
- Demand is expected to grow for secondary wood products as the U.S. housing market continues to expand.
- However, this favourable outlook for both segments is tempered by the increase in competition from low-cost international producers and possible cooling in the domestic housing market.

Source: Statistics Canada. See *Sources and information* for more detail.

Indicator:
Forest industry carbon emissions

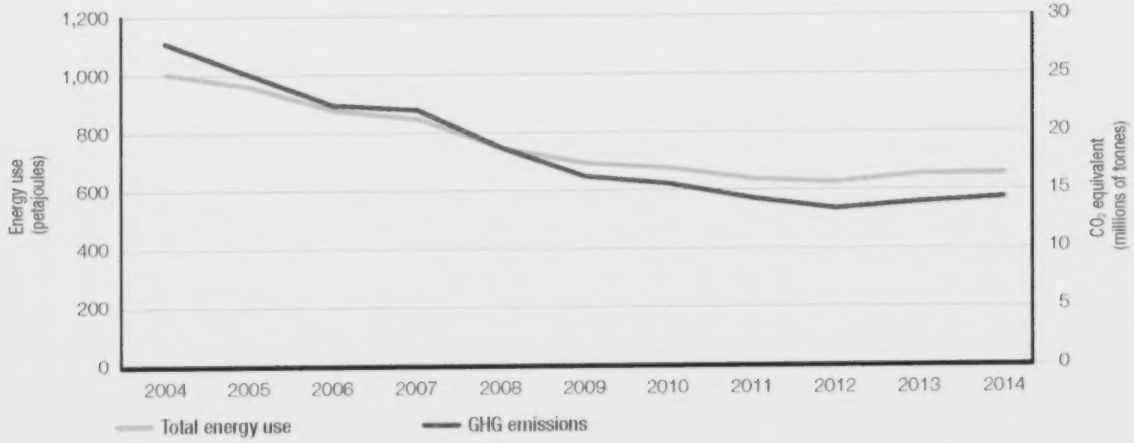
Energy use in the Canadian forest industry has steadily decreased over the last 10 years, while net greenhouse gas emissions (GHGs, expressed as carbon dioxide equivalents, or CO_2e) have fallen at an even steeper rate.

- The forest sector's ability to generate its own electricity, largely from bioenergy, has reduced its reliance on fossil fuels.
- Bioenergy continues to increase its share of the energy mix, accounting for 56% of forest industry energy use in 2014, up from 49% in 2000 and 43% in 1990.
- Between 2004 and 2014, the forest industry reduced energy use by 35% and GHG emissions by 49%.

Canada measures its national emission levels annually for all sectors and assesses how these compare with targets for greenhouse gas (GHG) reductions.

The forest industry has achieved both reductions in energy use, through greater efficiencies, and reductions in GHG emissions, by changing the fuel mix. Decreased production and the decline of the pulp and paper industry have also contributed to the trend.

Fossil fuel greenhouse gas (GHG) emissions and total energy use in Canada's forest industry, 2004–2014



Why is this indicator important?

- Scientists agree that there is a strong link between climate change and activities that burn fossil fuels and emit carbon dioxide, methane, nitrous oxide and other GHGs.
- By monitoring the forest industry's GHG emissions, we can assess how its emissions record has improved over time.

What is the outlook?

- Technologies that reduce energy use and GHG emissions provide significant environmental benefits and reduce energy costs for manufacturers. Investments in these technologies are expected to continue.
- Since overall reductions in GHG emissions will likely be tempered by increases in economic activity, GHG emissions and total energy use will likely continue to decline but at a slower rate.

Source: Statistics Canada, *Report on Energy Supply and Demand in Canada (2014 preliminary)*. See *Sources and information* for more detail.

Glossary: Canada's timber forest products

SOLID WOOD PRODUCTS

Logs: Trunk or large limbs of a felled tree. Used for log homes, solid wood and pulp products.

Squared timber: A large, squared piece of a log at least 5.5 inches wide. Used to form post-and-beam style buildings.

Sawnwood: Wood produced by sawing logs into smaller parts for further processing.

Lumber products: Wood of different sizes for different end-uses.

Dimension lumber: Softwood lumber of standardized sizes that is usually 2 inches thick (e.g. 2x4). Used to frame wood buildings like houses.

Boards: Softwood lumber of standardized sizes that is typically less than 2 inches thick. Used in manufacturing and carpentry.

Glued wood: Smaller boards glued or joined together to make larger or longer pieces of wood for structural and non-structural uses.

Machine stress rated (MSR): Softwood dimension lumber mechanically tested for strength. Used for engineered wood products such as roof trusses.

Shakes and shingles: Thin, tapered pieces of wood (usually cedar) used for roofing. Shakes are split from a block of wood. Shingles are sawn and more precisely milled.

Veneer: A thin layer of wood prepared by peeling or slicing a log. Used to overlay other wood products like cabinets, doors and furniture.

Panels: Sheets of wood or fibres glued together under heat and pressure.

Plywood: A structural panel made of multiple layers of wood veneers glued together with the grain of each layer perpendicular to that of the next. Used as a structural, load-bearing component of buildings.

Engineered wood: Manufactured wood products made from wood fibres and/or solid wood that can be designed and made to architects' and engineers' specifications:

Cross-laminated timber (CLT): Large structural panels made of multiple layers of lumber glued together at right angles to each other. Used in walls, floors and roofs; an alternative to concrete and steel systems.

I-beams: Structural wood products joined in the shape of an I. An alternative to dimension lumber in floor joists (supports) and roof rafters that uses 50% less wood.

Trusses: Structural frames with a triangular arrangement of webs and chords to transfer loads to reaction points. Used as a structural support in residential and non-residential roof structures.

Laminated veneer lumber (LVL): A structural material made of multiple layers of veneer glued together under heat and pressure. A substitute for dimension lumber.

Glue-laminated timber (Glulam): A structural product made of multiple pieces of lumber glued together in a desired form. Used in non-residential structural applications, often as part of architectural or aesthetic design.

Secondary wood products: Use of panels or lumber to create higher-value manufactured products, such as flooring, decking, furniture and cabinets.

Wood composites: Products made from wood waste or residues created in the manufacturing of other wood products.

Panels:

Oriented strand board (OSB): A structural panel made of strands or flakes of wood glued and pressurized together and oriented in different directions to achieve desired properties. Used as a load-bearing component in residential buildings.

Particle board: A non-structural panel made of small wood particles like shavings or sawdust. Used as a raw material in the production of finished goods, including ready-to-assemble furniture and cabinets.

Medium-density fibreboard (MDF): A non-structural panel made of very fine wood fibres. Used as a raw material in the production of finished goods, including ready-to-assemble furniture and cabinets.

BIOMATERIALS AND BIOCHEMICALS

A growing and diverse class of forest biomass-based products that are not typical pulp and paper or wood products.

Biomaterials: a range of novel materials made from forest biomass and typically used in industrial applications.

Biocomposites: Made of a resin matrix and reinforced with natural fibres.

Wood-plastic composites: Non-structural materials made from wood residues and recycled plastic. In North America, used outdoors as residential decks and railings; in Europe, used as automobile parts.

Wood-cement composites: Produced by mixing small pieces of wood with cement under pressure. Non-structural uses include acoustic ceiling tiles, siding and roadside noise barriers; structural uses include concrete-filled insulating forms.

Cellulose nanofibrils: A nanomaterial commonly processed into a liquid or gel form. Strengthens paper and board products and can also be used in biocomposites, paints and other high-value products.

Nanocrystalline cellulose (NCC): Cellulose in crystalline form processed into a solid flake, liquid or gel form. Used in the manufacture of new and advanced materials requiring, for example, strength and electromagnetic response.

Cellulose filaments (CF): An ultra-lightweight ribbon-like material with unique bonding properties. Provides extra strength and improved absorption in products such as facial tissues and paper towels without sacrificing softness.

Fibre mats: Carpet-like mats made from wood-fibre, with a variety of uses, including automotive composite mats and building insulation.

Lignin and lignin-blended (See also Biochemicals): One of the main components of wood, lignin gives wood its strength. It has a variety of uses, including:

Pulp-moulded products: Papermaking pulp moulded into packaging materials that snugly fit or separate fragile articles. Used for products such as egg cartons, domestic and utility trays, and bottle protectors.

Biochemicals: a range of chemical substances made from forest biomass and typically used in industrial applications.

Lignin and lignin-blended (See also Biomaterials): Lignin is one of the main components of wood, giving it its strength. Can be used as an alternative to fossil-fuel–based products. Has a variety of uses, such as:

Resins: Viscous (liquid or semi-liquid) substances derived from forest biomass and used as adhesives in industrial applications.

Thermoplastics: The most commonly used material in plastics processing. Softens with heat and solidifies when cooled.

Hemicellulose-based: One of the main components of wood, hemicellulose is a sugar that can be used as fuel or converted into other bioproducts, including sweeteners.

BIOENERGY

Biofuels: A fuel derived from plant biomass by chemical or geological processes.

Wood pellets: A fuel made from wood shavings, bark, sawdust and chips compressed or bound together. Low moisture content and easily transported over long distances.

Biomethanol: Methanol produced from biomass instead of the conventional raw material and processes.

Biogas: A combustible gas produced by the decomposition of biological materials (e.g., forestry residues and municipal waste).

PULP AND PAPER

Pulp: A fibrous material made by breaking down wood with mechanical force or chemicals. Used to produce paper and other materials.

Recycled pulp: Made from paper and packaging material. Used to manufacture new communication papers, packaging and paper towels.

Mechanical pulp: Made from wood fibres ground into very fine particles. Used to make newsprint and some other communications papers.

Semi-chemical pulp: Made from wood fibres broken down by both chemical and mechanical processes.

Bleached chemi-thermo mechanical pulp (BCTMP): A semi-chemical pulp that has been bleached. Used to produce printing and writing papers, coated papers, packaging and tissue.

Chemical pulp: Made from wood fibres broken down by chemicals (usually kraft or sulphite) instead of mechanical force.

Dissolving pulp: Has a high hemicellulose content and can be made from hardwood or softwood tree species. Used mostly for non-paper applications, such as manufacturing rayon and compounds for food and cosmetics.

Northern bleached softwood kraft (NBSK): Made from northern softwood species that grow in temperate forests. Used to make a wide variety of products, from communication papers to packaging and tissue and towel products.

Northern bleached hardwood kraft (NBHK): Made from northern hardwood species. Used to make a wide variety of products, from communication papers to tissue and paper towels.

Paper: Sheets of material produced from wood pulp. Has many uses, including for writing or printing on and packaging.

Communications paper: The most commonly produced paper in Canada. Includes:

Newsprint: Made from mechanical pulp. Used mostly to make newspapers.

Groundwood: Made from at least 20% mechanical pulp, and can be bleached or unbleached and coated or not, depending on desired characteristics. Uses include higher-quality coloured printing and magazines.

Freesheet: Made from at least 80% chemical pulp, and can be bleached or unbleached and coated or not, depending on desired characteristics. Uses include office paper for printing and copying.

Packaging: Thicker and stronger paper sheets used to wrap or contain materials and goods for storage and transport.

Boxboard: (also known as paperboard) A thick, strong paper material suitable for packaging lighter products, such as cereal or batteries.

Corrugated box: (also known as containerboard) Made from sheets of smooth boxboard with a wavy sheet in the middle.

Household and sanitary: Made for various uses around the home and for industrial and commercial purposes. Household papers include facial tissues, toilet paper, hand towels and napkins. Sanitary papers include products like baby diapers, adult incontinence products and sanitary napkins.

Specialty paper: A variety of distinctive papers designed and produced for particular uses, such as:

Thermal paper: Coated with a chemical that changes colour when exposed to heat. Used in thermal printers, cash registers and credit card terminals.

Labels: Have an adhesive on one side and are often coated on the other, for uses such as weight and price labels at grocery store.

Source: See *Sources and information* for details.

Statistical Profiles

Canada

Population (January 2017): 36,503,097
Arboreal emblem: Maple

Forest inventory

Forest and other wooded land by classification (hectares)	
Forest	347,069,000
Other wooded land	40,865,660
Other land with tree cover	8,498,940
Total area	396,433,600
Forest area change (hectares, 2015)	
Afforestation	Not available
Deforestation	34,100
Forest type (forest only)	
Coniferous	67.8%
Mixedwood	15.8%
Broadleaf	10.5%
Temporarily non-treed	5.9%
Forest ownership	
Provincial	76.6%
Territorial	12.9%
Private	6.2%
Aboriginal	2.0%
Federal	1.6%
Municipal	0.3%
Other	0.4%
Growing stock (million cubic metres)	
Total volume	47,320

Disturbance

Insects (hectares, 2015)	
Area defoliated by insects and containing beetle-killed trees	17,631,825
Fire (2016)	
Area burned (hectares)	1,404,655
Number of fires	5,243

Forest management

Harvesting (2015)	
Area harvested (hectares)	779,577
Volume harvested (cubic metres)	160,541,000
Regeneration (hectares, 2015)	
Area planted	413,373
Area seeded	13,050
Third-party certification (hectares, 2016)	
Area certified	167,797,442
Protected forest (IUCN categories)	
I a Strict nature reserve	0.1%
I b Wilderness area	1.9%
II Ecosystem conservation and protection	4.2%
III Conservation of natural features	0.5%
IV Conservation through active management	0.2%
V Landscape conservation and recreation	0.02%

Greenhouse gas inventory

For forest lands affected by land-use change (2015)	
Removals from the atmosphere due to afforestation (CO_2e/yr, megatonnes)	0.5
Total emissions due to deforestation (CO_2e/yr, megatonnes)	9.6
For managed forests (2015)	
Area of managed forests (hectares)	226,000,000
Total net emissions or removals to the atmosphere, all causes (CO_2e/yr, megatonnes)	221.0
Net emissions or removals due to natural disturbances (CO_2e/yr, megatonnes)	247.1
Net emissions or removals due to human forest management activities and from harvested wood products (CO_2e/yr, megatonnes)	-26.2
Transfers from the managed forest sector to the forest products sector due to harvesting (CO_2e/yr, megatonnes)	-164.0

Domestic economic impact

Canadian housing starts (2016)	197,916
Contribution to nominal GDP (current dollars, 2016)	
Forestry and logging industry	3,608,000,000
Pulp and paper product manufacturing industry	8,596,000,000
Wood product manufacturing industry	10,868,000,000
Total contribution to nominal GDP	23,073,000,000
Contribution to real GDP (constant 2007 dollars, 2016)	
Forestry and logging industry	4,286,000,000
Pulp and paper product manufacturing industry	7,188,000,000
Wood product manufacturing industry	10,152,000,000
Total contribution to real GDP	21,626,000,000
Revenue from goods manufactured (dollars, 2015)	
Forestry and logging industry	9,421,136,000
Pulp and paper product manufacturing industry	26,776,033,000
Wood product manufacturing industry	27,062,158,000
Total revenue from goods manufactured	63,259,327,000

Forest industry employment

Employment (number, 2016)	
Labour Force Survey	230,567
Survey of Employment, Payrolls and Hours	185,318
Canadian System of National Accounts	211,075
Direct and indirect employment	306,020
Wages and salaries (dollars, 2015)	
Forestry and logging industry	1,575,541,000
Pulp and paper manufacturing industry	3,596,253,000
Wood product manufacturing industry	4,617,747,000
Total wages and salaries	9,789,541,000

Trade

Balance of trade (total exports, dollars, 2016)	23,130,149,716
Value of exports (dollars, 2016)	
Primary wood products	1,442,233,349
Pulp and paper products	16,996,831,851
Wood-fabricated materials	15,930,151,778
Total value of exports	34,369,216,978
Value of imports (dollars, 2016)	
Primary wood products	524,890,681
Pulp and paper products	7,347,758,415
Wood-fabricated materials	3,366,418,166
Total value of imports	11,239,067,262

Domestic production and investment

Production (2016)	
Hardwood lumber (cubic metres)	1,563,000
Softwood lumber (cubic metres)	66,862,000
Newsprint (tonnes)	3,353,000
Printing and writing paper (tonnes)	2,995,000
Wood pulp (tonnes)	16,508,000
Structural panels (plywood and oriented strandboard, cubic metres)	8,729,000
Capital expenditures (dollars, 2016)	
Forestry and logging industry	377,100,000
Pulp and paper product manufacturing industry	770,000,000
Wood product manufacturing industry	1,004,200,000
Total capital expenditures	2,151,300,000
Repair expenditures (dollars, 2015)	
Forestry and logging industry	383,900,000
Pulp and paper product manufacturing industry	1,388,400,000
Wood product manufacturing industry	965,800,000
Total repair expenditures	2,738,100,000

Domestic consumption

Consumption (2016)	
Hardwood lumber (cubic metres)	1,650,000
Softwood lumber (cubic metres)	22,725,000
Newsprint (tonnes)	296,429
Printing and writing paper (tonnes)	1,310,293
Wood pulp (tonnes)	7,142,119
Structural panels (plywood and oriented strandboard, cubic metres)	4,182,213

See page 80 for background information and sources for the statistics presented in these tables.

British Columbia

Population (January 2017): 4,777,157
Arboreal emblem: Western redcedar

Disturbance

Insects (hectares, 2015)	
Area defoliated by insects and containing beetle-killed trees	4,562,433
Fire (2016)	
Area burned (hectares)	100,366
Number of fires	1,049

Forest management

Harvesting (2015)	
Area harvested (hectares)	192,615
Volume harvested (cubic metres)	67,970,000
Regeneration (hectares, 2015)	
Area planted	170,856
Area seeded	5,469
Third-party certification (hectares, 2016)	
Area certified	51,953,410

Domestic economic impact

Housing starts (2016)	41,843
Revenue from goods manufactured (dollars, 2015)	
Forestry and logging industry	4,564,289,000
Pulp and paper product manufacturing industry	4,803,851,000
Wood product manufacturing industry	9,894,669,000
Total revenue from goods manufactured	19,262,809,000

Forest industry employment

Employment (number, 2016)	
Labour Force Survey	59,942
Survey of Employment, Payrolls and Hours	51,716
Canadian System of National Accounts	55,215
Wages and salaries (dollars, 2015)	
Forestry and logging industry	701,747,000
Pulp and paper product manufacturing industry	581,531,000
Wood product manufacturing industry	1,507,069,000
Total wages and salaries	2,790,347,000

Trade

Balance of trade (total exports, dollars, 2016)	11,916,735,970
Value of domestic exports (dollars, 2016)	
Primary wood products	1,202,815,102
Pulp and paper products	3,935,796,645
Wood-fabricated materials	8,652,537,990
Total value of domestic exports	13,791,149,737
Value of imports (dollars, 2016)	
Primary wood products	51,647,118
Pulp and paper products	820,598,325
Wood-fabricated materials	1,002,168,324
Total value of imports	1,874,413,767

Alberta

Population (January 2017): 4,280,127
Arboreal emblem: Lodgepole pine

Disturbance

Insects (hectares, 2015)	
Area defoliated by insects and containing beetle-killed trees	3,237,625
Fire (2016)	
Area burned (hectares)	611,475
Number of fires	1,436

Forest management

Harvesting (2015)	
Area harvested (hectares)	96,538
Volume harvested (cubic metres)	28,064,000
Regeneration (hectares, 2015)	
Area planted	62,788
Area seeded	817
Third-party certification (hectares, 2016)	
Area certified	20,240,950

Domestic economic impact

Housing starts (2016)	24,533
Revenue from goods manufactured (dollars, 2015)	
Forestry and logging industry	937,032,000
Pulp and paper product manufacturing industry	1,924,589,000
Wood product manufacturing industry	3,211,515,000
Total revenue from goods manufactured	6,073,136,000

Forest industry employment

Employment (number, 2016)	
Labour Force Survey	18,283
Survey of Employment, Payrolls and Hours	15,615
Canadian System of National Accounts	16,445
Wages and salaries (dollars, 2015)	
Forestry and logging industry	202,482,000
Pulp and paper product manufacturing industry	Not available
Wood product manufacturing industry	599,941,000
Total wages and salaries	Not available

Trade

Balance of trade (total exports, dollars, 2016)	2,552,365,270
Value of domestic exports (dollars, 2016)	
Primary wood products	19,702,618
Pulp and paper products	1,793,936,978
Wood-fabricated materials	1,066,464,265
Total value of domestic exports	2,880,103,861
Value of imports (dollars, 2016)	
Primary wood products	2,800,770
Pulp and paper products	180,003,615
Wood-fabricated materials	144,934,206
Total value of imports	327,738,591

Saskatchewan

Population (January 2017): 1,158,339
Arboreal emblem: White birch

Disturbance	
Insects (hectares, 2015)	
Area defoliated by insects and containing beetle-killed trees	428,955
Fire (2016)	
Area burned (hectares)	241,608
Number of fires	364
Forest management	
Harvesting (2015)	
Area harvested (hectares)	17,416
Volume harvested (cubic metres)	3,712,000
Regeneration (hectares, 2015)	
Area planted	3,896
Area seeded	Not available
Third-party certification (hectares, 2016)	
Area certified	5,292,756
Domestic economic impact	
Housing starts (2016)	4,775
Revenue from goods manufactured (dollars, 2015)	
Forestry and logging industry	117,828,000
Pulp and paper product manufacturing industry	Not available
Wood product manufacturing industry	480,685,000
Total revenue from goods manufactured	Not available
Forest industry employment	
Employment (number, 2016)	
Labour Force Survey	2,808
Survey of Employment, Payrolls and Hours	Not available
Canadian System of National Accounts	3,110
Wages and salaries (dollars, 2015)	
Forestry and logging industry	20,230,000
Pulp and paper product manufacturing industry	Not available
Wood product manufacturing industry	94,472,000
Total wages and salaries	Not available
Trade	
Balance of trade (total exports, dollars, 2016)	489,803,043
Value of domestic exports (dollars, 2016)	
Primary wood products	3,218,072
Pulp and paper products	238,444,668
Wood-fabricated materials	304,732,464
Total value of domestic exports	546,395,204
Value of imports (dollars, 2016)	
Primary wood products	902,328
Pulp and paper products	28,304,189
Wood-fabricated materials	27,385,644
Total value of imports	56,592,161

Manitoba

Population (January 2017): 1,328,346
Arboreal emblem: White spruce

Disturbance	
Insects (hectares, 2015)	
Area defoliated by insects and containing beetle-killed trees	1,484,218
Fire (2016)	
Area burned (hectares)	38,408
Number of fires	202
Forest management	
Harvesting (2015)	
Area harvested (hectares)	10,686
Volume harvested (cubic metres)	1,498,000
Regeneration (hectares, 2015)	
Area planted	4,092
Area seeded	Not available
Third-party certification (hectares, 2016)	
Area certified	11,373,482
Domestic economic impact	
Housing starts (2016)	5,319
Revenue from goods manufactured (dollars, 2015)	
Forestry and logging industry	56,666,000
Pulp and paper product manufacturing industry	Not available
Wood product manufacturing industry	380,733,000
Total revenue from goods manufactured	Not available
Forest industry employment	
Employment (number, 2016)	
Labour Force Survey	5,667
Survey of Employment, Payrolls and Hours	Not available
Canadian System of National Accounts	4,700
Wages and salaries (dollars, 2015)	
Forestry and logging industry	14,183,000
Pulp and paper product manufacturing industry	70,464,000
Wood product manufacturing industry	97,773,000
Total wages and salaries	182,420,000
Trade	
Balance of trade (total exports, dollars, 2016)	-64,546,350
Value of domestic exports (dollars, 2016)	
Primary wood products	996,920
Pulp and paper products	214,713,896
Wood-fabricated materials	222,257,602
Total value of domestic exports	437,968,418
Value of imports (dollars, 2016)	
Primary wood products	3,731,006
Pulp and paper products	338,663,879
Wood-fabricated materials	160,119,883
Total value of imports	502,514,768

Ontario

Population (January 2017): 14,094,167
Arboreal emblem: Eastern white pine

Disturbance

Insects (hectares, 2015)	
Area defoliated by insects and containing beetle-killed trees	896,935
Fire (2016)	
Area burned (hectares)	83,113
Number of fires	648

Forest management

Harvesting (2015)	
Area harvested (hectares)	131,688
Volume harvested (cubic metres)	15,829,000
Regeneration (hectares, 2015)	
Area planted	43,676
Area seeded	6,708
Third-party certification (hectares, 2016)	
Area certified	26,788,856

Domestic economic impact

Housing starts (2016)	74,952
Revenue from goods manufactured (dollars, 2015)	
Forestry and logging industry	1,028,681,000
Pulp and paper product manufacturing industry	8,301,565,000
Wood product manufacturing industry	4,035,671,000
Total revenue from goods manufactured	13,365,917,000

Forest industry employment

Employment (number, 2016)	
Labour Force Survey	49,525
Survey of Employment, Payrolls and Hours	38,266
Canadian System of National Accounts	46,870
Wages and salaries (dollars, 2015)	
Forestry and logging industry	197,128,000
Pulp and paper product manufacturing industry	1,317,560,000
Wood product manufacturing industry	831,469,000
Total wages and salaries	2,346,157,000

Trade

Balance of trade (total exports, dollars, 2016)	-1,349,155,275
Value of domestic exports (dollars, 2016)	
Primary wood products	49,441,576
Pulp and paper products	2,981,615,613
Wood-fabricated materials	1,650,960,409
Total value of domestic exports	4,682,017,598
Value of imports (dollars, 2016)	
Primary wood products	66,468,255
Pulp and paper products	4,525,890,322
Wood-fabricated materials	1,438,814,296
Total value of imports	6,031,172,873

Quebec

Population (January 2017): 8,356,851
Arboreal emblem: Yellow birch

Disturbance

Insects (hectares, 2015)	
Area defoliated by insects and containing beetle-killed trees	6,321,420
Fire (2016)	
Area burned (hectares)	33,371
Number of fires	602

Forest management

Harvesting (2015)	
Area harvested (hectares)	202,060
Volume harvested (cubic metres)	28,559,000
Regeneration (hectares, 2015)	
Area planted	101,092
Area seeded	Not available
Third-party certification (hectares, 2016)	
Area certified	45,155,197

Domestic economic impact

Housing starts (2016)	38,935
Revenue from goods manufactured (dollars, 2015)	
Forestry and logging industry	1,943,664,000
Pulp and paper product manufacturing industry	8,485,092,000
Wood product manufacturing industry	7,409,014,000
Total revenue from goods manufactured	17,837,770,000

Forest industry employment

Employment (number, 2016)	
Labour Force Survey	73,725
Survey of Employment, Payrolls and Hours	57,780
Canadian System of National Accounts	65,035
Wages and salaries (dollars, 2015)	
Forestry and logging industry	281,926,000
Pulp and paper product manufacturing industry	1,029,025,000
Wood product manufacturing industry	1,200,105,000
Total wages and salaries	2,511,056,000

Trade

Balance of trade (total exports, dollars, 2016)	7,452,474,526
Value of domestic exports (dollars, 2016)	
Primary wood products	99,775,124
Pulp and paper products	6,193,066,005
Wood-fabricated materials	3,275,706,174
Total value of domestic exports	9,568,547,303
Value of imports (dollars, 2016)	
Primary wood products	334,173,559
Pulp and paper products	1,273,841,160
Wood-fabricated materials	508,058,058
Total value of imports	2,116,072,777

New Brunswick

Population (January 2017): 757,771
Arboreal emblem: Balsam fir

Disturbance

Insects (hectares, 2015)	
Area defoliated by insects and containing beetle-killed trees	4,700
Fire (2016)	
Area burned (hectares)	265
Number of fires	285

Forest management

Harvesting (2015)	
Area harvested (hectares)	83,345
Volume harvested (cubic metres)	9,363,000
Regeneration (hectares, 2015)	
Area planted	17,956
Area seeded	Not available
Third-party certification (hectares, 2016)	
Area certified	4,190,695

Domestic economic impact

Housing starts (2016)	1,838
Revenue from goods manufactured (dollars, 2015)	
Forestry and logging industry	564,766,000
Pulp and paper product manufacturing industry	1,827,036,000
Wood product manufacturing industry	Not available
Total revenue from goods manufactured	Not available

Forest industry employment

Employment (number, 2016)	
Labour Force Survey	13,083
Survey of Employment, Payrolls and Hours	9,993
Canadian System of National Accounts	13,310
Wages and salaries (dollars, 2015)	
Forestry and logging industry	97,778,000
Pulp and paper product manufacturing industry	234,289,000
Wood product manufacturing industry	Not available
Total wages and salaries	Not available

Trade

Balance of trade (total exports, dollars, 2016)	1,447,871,214
Value of domestic exports (dollars, 2016)	
Primary wood products	42,953,918
Pulp and paper products	1,046,525,096
Wood-fabricated materials	634,068,915
Total value of domestic exports	1,723,547,929
Value of imports (dollars, 2016)	
Primary wood products	65,158,350
Pulp and paper products	150,467,100
Wood-fabricated materials	60,051,265
Total value of imports	275,676,715

Nova Scotia

Population (January 2017): 952,024
Arboreal emblem: Red spruce

Disturbance

Insects (hectares, 2015)	
Area defoliated by insects and containing beetle-killed trees	458
Fire (2016)	
Area burned (hectares)	755
Number of fires	274

Forest management

Harvesting (2015)	
Area harvested (hectares)	34,777
Volume harvested (cubic metres)	3,749,000
Regeneration (hectares, 2015)	
Area planted	4,559
Area seeded	Not available
Third-party certification (hectares, 2016)	
Area certified	1,308,691

Domestic economic impact

Housing starts (2016)	3,767
Revenue from goods manufactured (dollars, 2015)	
Forestry and logging industry	121,183,000
Pulp and paper product manufacturing industry	Not available
Wood product manufacturing industry	Not available
Total revenue from goods manufactured	Not available

Forest industry employment

Employment (number, 2016)	
Labour Force Survey	5,467
Survey of Employment, Payrolls and Hours	Not available
Canadian System of National Accounts	4,380
Wages and salaries (dollars, 2015)	
Forestry and logging industry	31,920,000
Pulp and paper product manufacturing industry	Not available
Wood product manufacturing industry	Not available
Total wages and salaries	Not available

Trade

Balance of trade (total exports, dollars, 2016)	508,378,014
Value of domestic exports (dollars, 2016)	
Primary wood products	23,302,569
Pulp and paper products	420,640,909
Wood-fabricated materials	114,795,231
Total value of domestic exports	558,738,709
Value of imports (dollars, 2016)	
Primary wood products	65
Pulp and paper products	25,646,221
Wood-fabricated materials	24,714,409
Total value of imports	50,360,695

Prince Edward Island

Population (January 2017): 149,383
Arboreal emblem: Red oak

Disturbance

Insects (hectares, 2015)	
Area defoliated by insects and containing beetle-killed trees	75
Fire (2016)	
Area burned (hectares)	20
Number of fires	7

Forest management

Harvesting (2015)	
Area harvested (hectares)	2,760
Volume harvested (cubic metres)	371,000
Regeneration (hectares, 2015)	
Area planted	282
Area seeded	Not available
Third-party certification (hectares, 2016)	
Area certified	446

Domestic economic impact

Housing starts (2016)	556
Revenue from goods manufactured (dollars, 2015)	
Forestry and logging industry	10,210,000
Pulp and paper product manufacturing industry	Not available
Wood product manufacturing industry	Not available
Total revenue from goods manufactured	Not available

Forest industry employment

Employment (number, 2016)	
Labour Force Survey	458
Survey of Employment, Payrolls and Hours	Not available
Canadian System of National Accounts	445
Wages and salaries (dollars, 2015)	
Forestry and logging industry	1,617,000
Pulp and paper product manufacturing industry	Not available
Wood product manufacturing industry	Not available
Total wages and salaries	Not available

Trade

Balance of trade (total exports, dollars, 2016)	26,146,734
Value of domestic exports (dollars, 2016)	
Primary wood products	0
Pulp and paper products	25,855,031
Wood-fabricated materials	291,703
Total value of domestic exports	26,146,734
Value of imports (dollars, 2016)	
Primary wood products	0
Pulp and paper products	11,629
Wood-fabricated materials	9,186
Total value of imports	20,815

Newfoundland and Labrador

Population (January 2017): 529,696
Arboreal emblem: Black spruce

Disturbance

Insects (hectares, 2015)	
Area defoliated by insects and containing beetle-killed trees	85,921
Fire (2016)	
Area burned (hectares)	10,954
Number of fires	91

Forest management

Harvesting (2015)	
Area harvested (hectares)	7,360
Volume harvested (cubic metres)	1,392,000
Regeneration (hectares, 2015)	
Area planted	4,169
Area seeded	56
Third-party certification (hectares, 2016)	
Area certified	1,493,405

Domestic economic impact

Housing starts (2016)	1,398
Revenue from goods manufactured (dollars, 2015)	
Forestry and logging industry	75,824,000
Pulp and paper product manufacturing industry	Not available
Wood product manufacturing industry	58,349,000
Total revenue from goods manufactured	Not available

Forest industry employment

Employment (number, 2016)	
Labour Force Survey	1,667
Survey of Employment, Payrolls and Hours	Not available
Canadian System of National Accounts	1,330
Wages and salaries (dollars, 2015)	
Forestry and logging industry	26,354,000
Pulp and paper product manufacturing industry	Not available
Wood product manufacturing industry	Not available
Total wages and salaries	Not available

Trade

Balance of trade (total exports, dollars, 2016)	149,685,395
Value of domestic exports (dollars, 2016)	
Primary wood products	27,450
Pulp and paper products	146,186,625
Wood-fabricated materials	7,959,956
Total value of domestic exports	154,174,031
Value of imports (dollars, 2016)	
Primary wood products	9,193
Pulp and paper products	4,327,312
Wood-fabricated materials	152,131
Total value of imports	4,488,636

Yukon

Population (January 2017): 37,693
Arboreal emblem: Subalpine fir

Disturbance

Insects (hectares, 2015)	
Area defoliated by insects and containing beetle-killed trees	95,248
Fire (2016)	
Area burned (hectares)	21,543
Number of fires	53

Forest management

Harvesting (2015)	
Area harvested (hectares)	150
Volume harvested (cubic metres)	17,000
Regeneration (hectares, 2015)	
Area planted	7
Area seeded	Not available
Third-party certification (hectares, 2016)	
Area certified	0

Trade

Balance of trade (total exports, dollars, 2016)	338,989
Value of domestic exports (dollars, 2016)	
Primary wood products	0
Pulp and paper products	5,797
Wood-fabricated materials	348,646
Total value of domestic exports	354,443
Value of imports (dollars, 2016)	
Primary wood products	37
Pulp and paper products	4,653
Wood-fabricated materials	10,764
Total value of imports	15,454

Northwest Territories

Population (January 2017): 44,263
Arboreal emblem: Tamarack

Disturbance

Insects (hectares, 2015)	
Area defoliated by insects and containing beetle-killed trees	513,837
Fire (2016)	
Area burned (hectares)	254,982
Number of fires	189

Forest management

Harvesting (2015)	
Area harvested (hectares)	182
Volume harvested (cubic metres)	18,000
Regeneration (hectares, 2015)	
Area planted	Not available
Area seeded	Not available
Third-party certification (hectares, 2016)	
Area certified	0

Trade

Balance of trade (total exports, dollars, 2016)	44,510
Value of domestic exports (dollars, 2016)	
Primary wood products	0
Pulp and paper products	44,510
Wood-fabricated materials	0
Total value of domestic exports	44,510
Value of imports (dollars, 2016)	
Primary wood products	0
Pulp and paper products	0
Wood-fabricated materials	0
Total value of imports	0

Nunavut

Population (January 2017): 37,280

Trade

Balance of trade (total exports, dollars, 2016)	28,493
Value of domestic exports (dollars, 2016)	
Primary wood products	0
Pulp and paper products	80
Wood-fabricated materials	28,423
Total value of domestic exports	28,503
Value of imports (dollars, 2016)	
Primary wood products	0
Pulp and paper products	10
Wood-fabricated materials	0
Total value of imports	10

Sources and information

The data in this report are derived from a number of sources, which are identified here by their relevant section. All data are subject to revision. Some numbers are rounded and therefore may not always exactly match the sum of their elements.

In most cases, the data represent the year before the reporting period. However, where they are gathered from several sources, it generally takes longer to compile and produce them. In these cases, the numbers reflect results from two or three years before the reporting period. As well, while most figures are calculated for the calendar year (January 1 to December 31), some are based on the federal government's fiscal year (April 1 to March 31).

All dollar figures, unless specified otherwise, are in Canadian dollars.

It may not be possible to compare directly the data from the report's various sections, as they come from several sources and those sources may compile their statistics differently from each other.

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- Data from Statistics Canada's new Natural Resources Satellite Account (NRSA) are a key source of information

on the economic contribution of the forest sector in Canada and will be included in future releases of *The State of Canada's Forests* report. The NRSA, the result of collaboration between Natural Resources Canada and Statistics Canada, is able to capture additional economic activity in forest industry segments that have traditionally been difficult to measure, such as wood furniture manufacturing. According to data from the NRSA, the forest sector directly accounted for $25.2 billion (or 1.3%) of Canada's nominal GDP, and directly employed 221,623 people across the country in 2016.

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Photo credits:

- Image of glacier retreat: Excerpt from Fig. 2. Deglaciation in North America from the last glacial maximum at 21 400 – 6300 calendar years BP (adapted from Dyke et al. 2003). Reproduced with permission from An introduction to Canada's boreal zone: ecosystem processes, health, sustainability, and environmental issues. 2013. Brandt, J.P.; Flannigan, M.D.; Maynard, D.G.; Thompson, I.D.; Volney, W.J.A. Environmental Reviews 21(4): 207–226. http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/35234.pdf.

- Image d-03623 (Columbia River Lumber Company); Image f-09192 (Engine backing down a steep grade) and Image i-05785 (Naturalist and students at Creston Wildlife Centre) courtesy of the Royal BC Museum and Archives.

- Jos Montferrand postage stamp. Archival reference no. R169-5. ITEMLEV34086 Library and Archives Canada. LAC Mikan no. 2266335. Reproduced courtesy of Canada Post Corporation.

- Forestry products postage stamp [philatelic record]. Date of issue 1 April 1952. Library and Archives Canada. LAC Mikan 2185242. Reproduced courtesy of Canada Post Corporation.

- Photo depicting George Pocaterra at a forest registration station near the Ghost River, Alberta. Ca. 1962. Credit: Rosemary Gilliat Eaton / Library and Archives Canada. LAC Mikan 4308309.

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Photo credits:

- Smoke rises from wildfires burning in this aerial photograph taken above Fort McMurray, Alberta, on May 6, 2016. Photo by Darryl Dyck/Bloomberg via Getty Images.

- Smoke fills the air as a police officer stands guard at a roadblock along Highway 63 leading into Fort McMurray on May 8, 2016. Photo by Scott Olson/Getty Images.

- A sign expressing generosity in Plamondon, Canada, on May 5, 2016. Photo by Cole Burston/AFP via Getty Images.

- Marilou Wood fights back tears as husband Jim Wood fills up his car with gas after fleeing forest fires in Fort McMurray on May 4, 2016. Photo by Cole Burston/AFP via Getty Images.

- A Fort McMurray evacuee plays a guitar while lying on a cot at a hockey rink in Lac La Biche, Alberta on May 7, 2016. Photo by Darryl Dyck/Bloomberg via Getty Images.

Infographic: Why Canada's forests need fires

Natural Resources Canada–Canadian Forest Service. Fire ecology. https://www.nrcan.gc.ca/forests/fire-insects-disturbances/fire/13149

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- Landsat TM 5 image 1994–1997 processed by Luc Guindon and David Gervais, Natural Resources Canada.

Photo credits:

- Franck Tuot (morel mushrooms), Josée Noël, Université du Québec en Abitibi-Témiscamingue (jack pine seedling), Danielle Charron, Université du Québec à Montréal (deciduous and coniferous forests – fire year), David Gervais, NRCan (deciduous and coniferous forests – 15 years after).

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- Post-fire Fort McMurray neighbourhood and environs courtesy of Paul Colangelo.
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Article: Behind the fire: Science and systems for fire management

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- The Canadian Forest Fire Danger Rating System has been fully implemented in parts of the U.S. and New Zealand; and components are used in Spain, Portugal, Sweden, Mexico, Argentina, Fiji, Indonesia and Malaysia.

Photo credits:

- Fire monitoring and smoke plume photos courtesy of Bo Lu.

Infographic: 5 things you can learn from tree rings

CSIROpedia. SilviScan™ rapid wood analysis. https://csiropedia.csiro.au/silviscan-rapid-wood-analysis/

Girardin, M. 2016. Canadian boreal forest growth: Half a century of stability. Natural Resources Canada–Canadian Forest Service. *Branching Out* [series], Laurentian Forestry Centre No. 110. Québec, QC.

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- Martin Girardin (black spruce cross-section), National Forest Inventory (trembling aspen core), Martine Blais and Danny Rioux (cellular image).

Article: Canada's forest sector: Leading the way in the bioeconomy

Mason, Glenn, Assistant Deputy Minister, Canadian Forest Service [speech given at the annual Conference of the Pulp and Paper Industry in Canada, Montreal, QC, February 13–17, 2017.]

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Infographic and Glossary: Canada's timber forest products

FPInnovations. 2013. Cellulose filaments: An exciting opportunity for Canada's forest sector [fact sheet]. https://fpinnovations.ca/media/factsheets/Documents/cellulose-filaments.pdf

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Sustainability indicators

How much forest does Canada have?

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- The base estimate of forest area for Canada comes from the National Forest Inventory (NFI) baseline report of forest and non-forest land in Canada.

- The estimate of current forest area (2015) was calculated by taking the NFI baseline estimate at the source above and adjusting it for known increases in forest area (afforestation) and known decreases in forest area (deforestation) that occurred during the time since the NFI baseline data were collected. These adjustments are described in Canada's country report to the Food and Agriculture Organization (FAO) of the United Nations for *Global Forest Resources Assessment 2015*, listed above.

- The definition of "forest" can be found in the FAO's report *FRA 2015: Terms and Definitions*, listed above.

- Natural Resources Canada–Canadian Forest Services' National Deforestation Monitoring System and Forest Carbon Monitoring, Accounting and Reporting System both define "forest" as all areas of 1 hectare or more having the potential to develop forest cover, with a minimum crown closure of 25% and a minimum tree height of 5 metres at maturity in situ. This definition harmonizes with the definitions found in the Marrakesh Accords of the United Nations Framework Convention on Climate Change, but is different from the Food and Agriculture Organization of the United Nations' definition used elsewhere in this report.

Indicator: Forest area

Food and Agriculture Organization of the United Nations. 2012. *FRA 2015: Terms and definitions.* Forest Resources Assessment Working Paper 180. Rome, Italy. http://www.fao.org/docrep/017/ap862e/ap862e00.pdf

Food and Agriculture Organization of the United Nations. 2014. *Global forest resources assessment 2015 – Country report: Canada.* Rome, Italy. http://www.fao.org/documents/card/en/c/8202f908-3990-4321-a2b4-a2e346dbf68c/

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- The base estimate of forest area for Canada comes from the National Forest Inventory (NFI) baseline report at the source above.
- The estimate of current forest area (2015) was calculated by taking the NFI baseline estimate and adjusting it for known increases in forest area (afforestation) and known decreases in forest area (deforestation) that occurred during the time since the NFI baseline data were collected. These adjustments are described in Canada's country report to the Food and Agriculture Organization (FAO) of the United Nations for *Global Forest Resources Assessment 2015*, listed above.
- The Food and Agriculture Organization of the United Nations definition of "forest" and other terms are provided in *FRA 2015: Terms and Definitions*, listed above.
- Additional information can be found at:
  - **Dyk, A., Leckie, D.**, et al. 2015. *Canada's national deforestation monitoring system: System description.* Natural Resources Canada–Canadian Forest Service, Victoria, BC. http://cfs.nrcan.gc.ca/publications?id=36042
  - **Johnston, M., Campagna, M.**, et al. 2009. *Vulnerability of Canada's tree species to climate change and management options for adaptation: An overview for policy makers and practitioners.* Canadian Council of Forest Ministers, Ottawa ON. http://cfs.nrcan.gc.ca/publications?id=30276
  - **Natural Resources Canada–Canadian Forest Service.** Changing climate, changing forest zones. http://www.nrcan.gc.ca/forests/climate-change/impacts/13093
  - **Price, D.T., Alfaro, R.I., et al.** 2013. Anticipating the consequences of climate change for Canada's boreal forest ecosystems. Environmental Reviews 21, 322–365. http://cfs.nrcan.gc.ca/publications?id=35306

Indicator: Deforestation and afforestation

Environment and Climate Change Canada. 2017. National inventory report 1990–2015: *Greenhouse gas sources and sinks in Canada.* https://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=662F3C56-1

United Nations Framework Convention on Climate Change. 2002. *Report on the conference of the parties on its seventh session, held at Marrakesh from 29 October to 10 November 2001, Addendum, Part Two: Action taken by the conference of the parties*, FCCC/CP/2001/13/Add.1 (January 21, 2002). http://unfccc.int/resource/docs/cop7/13a01.pdf#page=54

- National deforestation estimates are calculated on a periodic basis using the method described in the national deforestation monitoring system description report. For more information, see:
  - **Dyk, A., Leckie, D., et al.** 2015. *Canada's national deforestation monitoring system: System description.* Natural Resources Canada–Canadian Forest Service, Victoria, BC. http://cfs.nrcan.gc.ca/publications?id=36042
- Natural Resources Canada–Canadian Forest Services' National Deforestation Monitoring System and Forest Carbon Monitoring, Accounting and Reporting System both define "forest" as all areas of 1 hectare or more having the potential to develop forest cover, with a minimum crown closure of 25% and a minimum tree height of 5 metres at maturity in situ. This definition harmonizes with the definitions found in the Marrakesh Accords of the United Nations Framework

Convention on Climate Change, but is different from the Food and Agriculture Organization of the United Nations' definition used elsewhere in this report.

- Environment and Climate Change Canada's *National Inventory Report 1990–2015: Greenhouse Gas Sources and Sinks in Canada* is based on data and analysis from Natural Resources Canada–Canadian Forest Service's National Forest Carbon Monitoring, Accounting and Report System.
- All values reported are for the listed year.
- Values were updated with new mapping, affecting estimates from 2004 onward.
- Forestry numbers result from the creation of permanent forestry access roads.
- Hydroelectric numbers exclude reservoirs. See the indicator text for magnitudes of deforestation resulting from reservoir flooding.
- Industry numbers result from industrial, institutional or commercial developments.
- Peat mines have been excluded, as they are below 100 hectares/year.
- Municipal numbers include urban development.
- Recreation numbers include ski hills and golf courses.
- Total numbers are adjusted for rounding.

Indicator: Wood volume

National Forest Inventory. Standard reports, Table 15.1, Total tree volume (million m^3) on forest land by forest type, age class, and terrestrial ecozone in Canada. https://nfi.nfis.org/resources/general/summaries/en/html/NFI3_T15_FORAGE20_VOL_en.html (accessed March 13, 2017).

- Additional information on outlook for wood volume is available at:
  - **Gauthier, S., Bernier, P., et al.** 2015. Boreal forest health and global change. *Science* 349, 819–822. http://cfs.nrcan.gc.ca/publications?id=36186
  - **Gauthier, S., Bernier, P.Y., et al.** 2015. Vulnerability of timber supply to projected changes in fire regime in Canada's managed forests. *Canadian Journal of Forest Research* 45, 1439–1447. http://cfs.nrcan.gc.ca/publications?id=36169
  - **Girardin, M.P., Hogg, E.H., et al.** 2016. Negative impacts of high temperatures on growth of black spruce forests intensify with the anticipated climate warming. *Global Change Biology* 22, 627–643. http://cfs.nrcan.gc.ca/publications?id=36216
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Is timber being harvested sustainably?

National Forest Inventory. Standard reports, Table 12.0, Area of forest land by ownership in Canada. https://nfi.nfis.org/resources/general/summaries/en/html/CA3_T12_FOROWN_AREA_en.html (accessed April 28, 2017).

National Forestry Database. Forest products – National tables, Table 5.1g, Industrial roundwood production by ownership, 2015. http://nfdp.ccfm.org/data/graphs/graph_51_g_e.php (accessed June 30, 2017).

National Forestry Database. Wood supply – Quick facts, Annual harvest versus wood supply, 1990–2015. http://nfdp.ccfm.org/supply/quick_facts_e.php (accessed June 30, 2017).

Indicator: Area harvested

National Forestry Database. Silviculture – National tables, Table 6.2, Area harvested by ownership, harvesting method and province/territory, 1990–2015. http://nfdp.ccfm.org/data/compendium/html/comp_62e.html (accessed June 30, 2017).

- Data include provincial Crown and private forest land subject to even-aged management (clearcutting), uneven-aged management (selection cutting), and commercial thinning harvest methods.
- Graph does not display federal lands because their small area cannot be represented at the given scale.

Indicator: Regeneration

National Forestry Database. Silviculture – National tables, Table 6.6, Area of direct seeding by ownership and province/territory, 1990–2015. http://nfdp.ccfm.org/data/compendium/html/comp_66e.html (accessed June 30, 2017).

National Forestry Database. Silviculture – National tables, Table 6.7, Area planted by ownership, species, and province/territory, 1990–2015. http://nfdp.ccfm.org/data/compendium/html/comp_67e.html (accessed June 30, 2017).

National Forestry Database. Silviculture – National tables, Table 6.8, Number of seedlings planted by ownership, species and province/territory, 1990–2015. http://nfdp.ccfm.org/data/compendium/html/comp_68e.html (accessed June 30, 2017).

- Data are for forests on provincial Crown lands across Canada.
- Federally and privately owned lands are excluded.
- Artificial regeneration rates tend to lag behind harvest rates because of the time that may be required for planning, production of seedlings, and site preparation.
- Natural regeneration is often the most efficient approach for regenerating harvested areas when there is abundant existing understorey regeneration and a plentiful seed supply (e.g. lowland black spruce and tolerant hardwoods, respectively), or when tree species that can resprout from established root systems are present and desired (e.g. trembling aspen).
- Artificial regeneration is suitable for sites where there is insufficient desired natural regeneration and where the objective is to achieve species composition targets required for sustainable forest management objectives.

Indicator: Volume harvested relative to sustainable wood supply

National Forestry Database. Wood supply – Quick facts, Annual harvest versus wood supply, 1990–2015. http://nfdp.ccfm.org/supply/quick_facts_e.php (accessed June 30, 2017).

- Harvests include industrial roundwood only and exclude fuel wood and firewood.
- Wood supply includes allowable annual cuts (AACs) for provincial Crown lands and potential harvests for federal and private lands.
- The discrepancy between the harvested volumes of "total industrial roundwood" and the sum of the "total industrial softwoods" and "total industrial hardwoods" is due to a very small amount of harvest categorised as "unspecified." Typically, this harvest occurs in mixedwood forests where neither softwood nor hardwood categories strictly apply, and accounts for less than 1% of the harvested volume of total industrial roundwood. More information on these data can be found at the National Forestry Database, listed above.

How does disturbance shape Canada's forests?

Boulanger, Y., Gauthier, S., et al. 2014. A refinement of models projecting future Canadian fire regimes using homogeneous fire regime zones. *Canadian Journal of Forest Research* 44, 365–376. http://cfs.nrcan.gc.ca/publications?id=35420

Gauthier, S., Bernier, P., et al. 2014. Climate change vulnerability and adaptation in the managed Canadian boreal forest. *Environmental Reviews* 22, 256–285. http://cfs.nrcan.gc.ca/publications?id=35357

Gauthier, S., Bernier, P., et al. 2015. Boreal forest health and global change. Science 349, 819–822. http://cfs.nrcan.gc.ca/publications?id=36186

Nealis, V., and Cooke, B. 2014. *Risk assessment of the threat of mountain pine beetle to Canada's boreal and eastern pine forests.* Canadian Council of Forest Ministers, Ottawa, ON. http://cfs.nrcan.gc.ca/publications?id=35406

Sambaraju, K., DesRochers, P., et al. 2016. Forest ecosystem health and biotic disturbances: Perspectives on indicators and management approaches. In *Ecological Forest Management Handbook*. Larocque, G. (ed.), pp. 459–515. CRC Press, Boca Raton, FL. https://cfs.nrcan.gc.ca/publications?id=36837

Indicator: Forest diseases

Ennos, R.A. 2015. Resilience of forests to pathogens: An evolutionary ecology perspective. *Forestry* 88, 41–52.

Price, D.T., Alfaro, R.I., et al. 2013. Anticipating the consequences of climate change for Canada's boreal forest ecosystems. *Environmental Reviews* 21, 322–365.

Ramsfield, T.D., Bentz, B.J., et al. 2016. Forest health in a changing world: Effects of globalization and climate change on forest insect and pathogen impacts. *Forestry* 89, 245–252.

Sturrock, R.N., Frankel, S.J., et al. 2011. Climate change and forest diseases. *Plant Pathology* 60, 133–149.

Woods, A.J., Martín-García, J., et al. 2016. Dothistroma needle blight, weather and possible climatic triggers for the disease's recent emergence. *Forest Pathology* 46(5), 443–452.

Indicator: Forest insects

BC Ministry of Forests, Lands and Natural Resource Operations. 2015. *2015 summary of forest health conditions in British Columbia.* http://www2.gov.bc.ca/assets/gov/environment/research-monitoring-and-reporting/monitoring/aerial-overview-survey-documents/2015-fh-bc-overview.pdf (accessed April 22, 2016).

National Forestry Database. Forest insects – National tables, Table 4.1, Area within which moderate to severe defoliation occurs, including area of beetle-killed trees by insects and province/territory, 1975–2015. http://nfdp.ccfm.org/data/compendium/html/comp_41e.html (accessed June 30, 2017).

- Forest area disturbed by defoliators includes only areas with tree mortality and moderate to severe defoliation. Defoliation does not always imply mortality. For example, stands with moderate defoliation often recover and may not lose much growth.

- Defoliation is mapped on an insect species basis, and a given area may be affected by more than one species at a time. This may result in double or triple counting in areas affected by more than one species, exaggerating the extent of the total area defoliated.

Spotlight: Citizen scientists and the eastern spruce budworm outbreak

Healthy Forest Partnership. http://healthyforestpartnership.ca (accessed April 24, 2017).

Ministère des Forêts, de la Faune et des Parcs. 2016. Aires infestées par la tordeuse des bourgeons de l'épinette au Québec en 2016 (Version 1.0). Québec, QC: Gouvernement du Québec, Direction de la protection des forêts. (Available only in French.) https://www.mffp.gouv.qc.ca/publications/forets/fimaq/insectes/tordeuse/TBE_2016_P.pdf

Morris, R.F. (ed.) 1963. The dynamics of epidemic spruce budworm populations. *Memoirs of the Entomological Society of Canada 95* (S31), 7–12.

Pureswaran, D.S., Johns, R., et al. 2016. Paradigms in eastern spruce budworm (Lepidoptera: Tortricidae) population ecology: A century of debate. *Environmental Entomology* 45(6), 1333–1342.

- For more information on the Budworm Tracker program, or to volunteer, visit: http://budwormtracker.ca/#/

Photo credit:

- Vehicle in Campbellton, NB, covered in spruce budworm moths in 1957, from R.F. Morris, 1963.

Indicator: Forest fires

National Forestry Database. Forest fires – National tables, Table 3.1, Forest fire statistics by province/territory/agency, 1990–2016. http://nfdp.ccfm.org/data/compendium/html/comp_31e.html (accessed June 30, 2017).

Indicator: Carbon emissions and removals

Environment Canada. 2017. *National inventory report 1990–2015: Greenhouse gas sources and sinks in Canada.* http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/10116.php

- This indicator is estimated annually using Natural Resources Canada–Canadian Forest Service's National Forest Carbon Monitoring, Accounting and Reporting System. The system integrates information about forest inventories, forest growth, natural disturbances, forest management activities and land-use change to evaluate carbon stocks, stock changes and emissions of non-CO_2 greenhouse gases in Canada's managed forests. The system also estimates transfers to the forest product sector and the fate of harvested wood products manufactured from wood harvested in Canada, including carbon storage and emissions resulting from these products.

- For the purpose of greenhouse gas reporting, "Managed land" includes all lands managed for production of wood fibre or wood-based bioenergy, for protection from natural disturbances, or for the conservation of ecological values. Within those managed lands, "forest" includes all areas of 1 hectare or more having the potential to develop forest cover, with a minimum crown closure of 25% and a minimum tree height of 5 metres at maturity in situ.

- Insect-affected areas shown in Figures 2 and 3 include only those areas affected by insects that cause more than 20% tree mortality and thus have a substantial impact on national forest carbon emissions and removals.

- The data presented in this indicator do not yet estimate or report on emissions resulting from the impacts of the spruce budworm outbreak in Quebec.

- When stands are affected by wildfires, the emissions and the removals during post-fire regrowth are reported separately for a period of 60 years. Stands affected by partial disturbances that cause more than 20% mortality are similarly reported separately until the biomass reaches pre-disturbance levels.

- Starting in 2015, international greenhouse gas (GHG) reporting guidelines changed with respect to harvested wood products. Accordingly, Canada reports the net GHG balance of forested ecosystems and the net GHG balance from harvested wood products. Harvested wood product emissions are estimated using the "Production Approach" of the Intergovernmental Panel on Climate Change (IPCC) and include annual emissions from all wood harvested in Canada since 1941, regardless of its current location. Transfers of wood and paper products to landfills are assumed to oxidize instantly as CO_2.

- In previous years, all wood removed from the forest was assumed to instantly release all carbon to the atmosphere, despite the long-term storage of carbon in houses and other long-lived wood products. Reporting the fate of carbon in harvested wood products encourages both the sustainable management of forests and the management of harvested wood products aimed at extending carbon storage.

- Additional information can be found at:

  - **Kurz, W.A., Shaw, C.H., et al.** 2013. Carbon in Canada's boreal forest: A synthesis. *Environmental Reviews* 21, 260–292. http://cfs.nrcan.gc.ca/publications?id=35301

  - **Lemprière, T.C., Kurz, W.A., et al.** 2013. Canadian boreal forests and climate change mitigation. Environmental Reviews 21, 293–321. http://cfs.nrcan.gc.ca/publications?id=35627

  - **Natural Resources Canada–Canadian Forest Service.** Carbon budget model. http://www.nrcan.gc.ca/forests/climate-change/carbon-accounting/13107 (accessed May 3, 2017).

  - **Natural Resources Canada–Canadian Forest Service.** Inventory and land-use change. http://www.nrcan.gc.ca/forests/climate-change/carbon-accounting/13111 (accessed May 3, 2017).

  - **Stinson, G., Kurz, W.A., et al.** 2011. An inventory-based analysis of Canada's managed forest carbon dynamics, 1990 to 2008. *Global Change Biology* 17, 2227–2244. http://cfs.nrcan.gc.ca/publications?id=32135

How do forests benefit Canadians?

Mosquin, T., Whiting, P., et al. 1995. *Canada's Biodiversity: The variety of life, its status, economic benefits, conservation costs and unmet needs.* Canadian Centre for Biodiversity, Canadian Museum of Nature. Ottawa, ON.

Natural Resources Canada–Canadian Forest Service calculations based on Statistics Canada, 2011 Census of Population.

Statistics Canada. CANSIM table 383-0031: Labour statistics consistent with the System of National Accounts (SNA), by province and territory, job category and North American Industry Classification System (NAICS). http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=3830031 (accessed May 26, 2017).

Statistics Canada. Labour Force Survey (special extraction).

- Data from Statistics Canada's new Natural Resources Satellite Account (NRSA) are a key source of information on the economic contribution of the forest sector in Canada and will be included in future releases of *The State of Canada's Forests* report. The NRSA, the result of collaboration between Natural Resources Canada and Statistics Canada, is able to capture economic activity in forest industry segments that have traditionally been difficult to measure, such as wood furniture manufacturing. According to data from the NRSA, the forest sector directly accounted for $25.2 billion (or 1.3%) of Canada's nominal GDP, and directly employed 221,623 people across the country in 2016.

Indicator: Employment

Statistics Canada. CANSIM table 383-0031: Labour statistics consistent with the System of National Accounts (SNA), by province and territory, job category and North American Industry Classification System (NAICS). http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=3830031 (accessed May 26, 2017).

- Data from Statistics Canada's new Natural Resources Satellite Account (NRSA) are a key source of information on the economic contribution of the forest sector in Canada and will be included in future releases of *The State of Canada's Forest* report. The NRSA is the result of collaboration between NRCan and Statistics Canada and is able to capture additional economic activity in segments of the forest industry that have traditionally been difficult to measure, such as wood furniture manufacturing. According to data from the NRSA, the forest sector directly employed 221,623 people across the country in 2016.

Indicator: Average earnings

Statistics Canada. CANSIM table 281-0027: Survey of Employment, Payrolls and Hours (SEPH), average weekly earnings by type of employee overtime status and detailed North American Industry Classification System (NAICS). http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=2810027 (accessed March 28, 2017).

Statistics Canada. CANSIM table 326-0020: Consumer Price Index. http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=3260020 (accessed April 7, 2017).

- Additional information can be found at:
  - Natural Resources Canada–Canadian Forest Service. Industry – Overview. http://www.nrcan.gc.ca/forests/industry/13311
- Data excludes overtime.
- Previous issues of *The State of Canada's Forest* calculated real average earnings using GDP at market prices as the measure of inflation. This year, the Consumer Price Index (including volatile commodities) was used because it is a better indicator of the spending power of Canadians.

Indicator: Communities

Canadian Institute of Forestry. 2003. Policy paper: Forest-based communities. *Voice of Forest Practitioners*, Mattawa, ON.

Natural Resources Canada–Canadian Forest Service calculations based on Statistics Canada, 2011 Census of Population, 2011 National Household Survey and Labour Force Survey.

- Demographic data from the 2016 Census of Population was not available at the time of this report's publication. Therefore, two of the indicators will await updating in the next edition of *The State of Canada's Forests*.
- A decline in this indicator may reflect either a decline in the fortunes of the forest sector (e.g. if a mill closes, the income from the forest sector goes down) or an increase in diversification of the economy overall (e.g. there may be no changes to forest sector income, but other sources of income increase). As a result, an increasing or a declining trend in the number of census subdivisions having the forest sector as a major economic driver is hard to interpret in the absence of other information.
- A "forested area" is defined for this indicator as an area with over 60% tree cover.
- All communities indicators are based on Statistics Canada's census subdivisions. A "subdivision" is defined as an "area that is a municipality or an area that is deemed to be equivalent to a municipality for statistical reporting purposes (e.g. as an Indian reserve or an unorganized territory)." Since there is no standardized definition of "community" across provinces and territories, adopting the use of census subdivisions ensures consistency in reporting over time.
- The forest sector is considered to be a major economic driver if it accounts directly for 20% or more of total income (excluding transfer income) in a census subdivision. This differs from the previous definition of "forest dependence," which was based on more than 50% of total income (including transfer income) being directly attributable to the forest sector.

Spotlight: Indigenous communities and the forest economy

Natural Resources Canada–Canadian Forest Service, Indigenous Forestry Initiative, Biocoal – a new market for a new Québec First Nations group, 2017. [Unpublished success story.]

Natural Resources Canada–Canadian Forest Service, Indigenous Forestry Initiative, Non-timber harvest an ideal future for Algonquin First Nations, 2017. [Unpublished success story.]

Statistics Canada. Labour Force Survey (special extraction).

- Natural Resources Canada–Canadian Forest Service's calculations based on Statistics Canada, 2011 Census of Population, 2011 National Household Survey.
- Demographic data from the 2016 Census of Population was not available at the time of this report's publication.
- A "forested area" is defined as an area with over 60% tree cover for this Spotlight article.

Photo credit:

- Photo of spruce biochar chips courtesy of Agrinova.

How does the forest industry contribute to Canada's economy?

National Forestry Database. Revenues – National tables, Table 8.1, Statement of revenues from the sale of timber from provincial Crown land, 1990–2015. http://nfdp.ccfm.org/revenues/national_e.php (accessed June 30, 2017).

Statistics Canada. CANSIM table 383-0031: Labour statistics consistent with the System of National Accounts (SNA), by province and territory, job category and North American Industry Classification System (NAICS). http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=3830031 (accessed April 20, 2017).

Statistics Canada. Labour Force Survey (special extraction) (accessed March 14, 2017).

Statistics Canada. Merchandise trade data, monthly data (special extraction) (accessed April 20, 2017).

- Natural Resources Canada–Canadian Forest Service's calculations based on Statistics Canada's table 379-0031: GDP in 2007 constant prices, and estimated industry price deflators.

Indicator: Gross domestic product

Nominal GDP: Natural Resources Canada–Canadian Forest Service's calculations based on Statistics Canada's tables 379-0031, 329-0077, 329-0074 and 379-0029: GDP in 2007 constant prices, and estimated industry price deflators.

Real GDP: Statistics Canada. CANSIM table 379-0031: Gross domestic product (GDP) at basic prices, by North American Industry Classification System (NAICS). http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=3790031 (accessed May 26, 2017).

- Real GDP in 2007 constant prices.
- Data from Statistics Canada's new Natural Resources Satellite Account (NRSA) are a key source of information on the economic contribution of the forest sector in Canada and will be included in future releases of *The State of Canada's Forests* report. The NRSA, the result of collaboration between Natural Resources Canada and Statistics Canada, is able to capture economic activity in forest industry segments that have traditionally been difficult to measure, such as wood furniture manufacturing. According to data from the NRSA, the forest sector directly accounted for $25.2 billion (or 1.3%) of Canada's nominal GDP in 2016.

Indicator: Production

APA – The Engineered Wood Association. Quarterly production reports.

Pulp and Paper Products Council.

Statistics Canada. CANSIM table 303-0064: Lumber production, shipments and stocks, by Canada and provinces. http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=3030064 (accessed March 31, 2017).

- Data used for lumber production include total softwood production for Canada.

Indicator: Exports

Statistics Canada. Merchandise trade data (obtained via Global Trade Atlas). (accessed April 10, 2017).

- "Total all forest products" includes only HS Codes 44, 47 and 48.

How is the forest industry changing?

Natural Resources Canada. Comprehensive energy use database. http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive_tables/list.cfm (accessed April 19, 2017).

- Industrial Sector – Aggregated Industries
  - Table 8: Pulp and Paper Secondary Energy Use and GHG Emissions
  - Table 15: Forestry Secondary Energy Use and GHG Emissions
- Industrial Sector – Disaggregated Industries
  - Table 28: Wood Products Industries Secondary Energy Use and GHG Emissions
  - Table 34: Converted Paper Products Industry Secondary Energy Use and GHG Emissions

Statistics Canada. 2016. *Report on energy supply and demand in Canada*, 1990–2014, Ottawa. (2014 preliminary) http://www.statcan.gc.ca/pub/57-003-x/57-003-x2016002-eng.htm (accessed April 20, 2017).

- The methodology for estimating the amount of primary energy attributed to wood and spent pulping liquor in the pulp and paper manufacturing sub-sector was updated in 2015, causing changes in the data series

between 1995 and 2002. In addition, from 1990 to 2010, wood waste and spent pulping liquor were incorrectly included in other fuels when estimating electricity generation in the Report on Energy Supply and Demand in Canada. This has now been corrected for the 2011, 2012 and 2013 data points, but will not be corrected for years prior to those. These changes have directly affected the estimates for industrial energy use and electricity generation, and indirectly affected the emissions estimates. The time series data for 2011–2013 may therefore not be completely consistent with data for earlier years.

- Additional information about the Natural Resources Canada–Canadian Forest Service's Investments in Forest Industry Transformation Program can be found at http://www.nrcan.gc.ca/forests/federal-programs/13139.

Indicator: Financial performance

Statistics Canada. Quarterly financial statistics for enterprises (61-008-X) (special extraction).

Indicator: Secondary manufacturing

Industry Canada. Trade data online. https://www.ic.gc.ca/app/scr/tdst/tdo/crtr.html?productType=NAICS&lang=eng (accessed March 27, 2017).

Statistics Canada. CANSIM table 304-0014: Manufacturers' sales, inventories, orders and inventory to sales ratios, by North American Industry Classification System (NAICS), Canada. http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=3040014 (accessed March 27, 2017).

Statistics Canada. CANSIM table 379-0031: Gross domestic product (GDP) at basic prices, by North American Industry Classification System (NAICS). http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=3790031 (accessed March 27, 2017).

- Data based on chained (2007) dollars.
- Industry Canada defines "value added" as a measure of net output, meaning gross output minus the purchased inputs that have been embodied in the value of the product.
- Domestic consumption is calculated as domestic sales minus exports plus imports.

Indicator: Forest industry carbon emissions

Natural Resources Canada. Comprehensive energy use database. http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive_tables/list.cfm (accessed April 19, 2017).

- Industrial Sector – Aggregated Industries:
  - Table 8: Pulp and Paper Secondary Energy Use and GHG Emissions
  - Table 15: Forestry Secondary Energy Use and GHG Emissions
- Industrial Sector – Disaggregated Industries:
  - Table 28: Wood Products Industries Secondary Energy Use and GHG Emissions
  - Table 34: Converted Paper Products Industry Secondary Energy Use and GHG Emissions

Statistics Canada. 2016. *Report on energy supply and demand in Canada: 2014 preliminary* (catalogue no. 57-003-X). http://www.statcan.gc.ca/pub/57-003-x/57-003-x2016002-eng.htm (accessed April 20, 2017).

- The methodology for estimating the amount of primary energy attributed to wood and spent pulping liquor in the pulp and paper manufacturing sub-sector was updated in 2015, causing changes in the data series between 1995 and 2002. In addition, from 1990 to 2010, wood waste and spent pulping liquor were incorrectly included in other fuels when estimating electricity generation in the *Report on Energy Supply and Demand in Canada*. This has now been corrected for the 2011, 2012 and 2013 data points, but will not be corrected for years prior to those. These changes have directly affected the estimates for industrial energy use and electricity generation and indirectly affected the emissions estimates. The time series data for 2011–2013 may therefore not be completely consistent with data for earlier years.

Statistical profiles

Forest inventory

Forest and other wooded land by classification

National Forest Inventory. Standard reports, Table 4.0, Area (1000 ha) of forest and non-forest land in Canada. https://nfi.nfis.org/resources/general/summaries/en/html/CA3_T4_FOR_AREA_en.html (accessed May 1, 2017).

- The National Forest Inventory uses the following definitions from the Food and Agriculture Organization of the United Nations (FAO):

  - *Forest* – land spanning more than 0.5 hectares where the tree canopy covers more than 10% of the total land area and the trees can grow to a height of more than five metres. It does not include land that is predominantly urban or used for agricultural purposes.

  - *Other land with tree cover* – areas of land where tree canopies cover more than 10% of the total area and the trees, when mature, can grow to a height of at least five metres. Includes treed areas on farms, in parks and gardens, and around buildings. Also includes tree plantations established mainly for purposes other than wood production, such as fruit orchards.

  - *Other wooded land* – areas of land where: 1) tree canopies cover 5%–10% of the total area and the trees, when mature, can grow to a height above five metres; or 2) shrubs, bushes and trees together cover more than 10% of the area. These areas include treed wetlands (swamps) and land with slow-growing and scattered trees. They do not include land that is predominantly agricultural or urban.

- The base estimate of forest area for Canada comes from the National Forest Inventory baseline report, available at https://nfi.nfis.org/resources/general/summaries/en/html/CA3_T4_FOR_AREA_en.html

- The estimate of current forest area (2015) was calculated by taking the National Forest Inventory baseline estimate at the source above and adjusting it for known increases in forest area (afforestation) and known decreases in forest area (deforestation) that occurred during the time since baseline data were collected. These adjustments are described in Canada's 2015 country report to the Food and Agriculture Organization of the United Nations, available at http://www.fao.org/forest-resources-assessment/current-assessment/country-reports/en/

Forest area change

Environment and Climate Change Canada. 2017. *National Inventory Report 1990–2015: Greenhouse gas sources and sinks in Canada.* https://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=662F9C56-1

- Environment and Climate Change Canada's National Inventory Report 1990–2015: Greenhouse Gas Sources and Sinks in Canada is based on data and analysis from Natural Resources Canada–Canadian Forest Service's National Forest Carbon Monitoring, Accounting and Report System.

Forest type

National Forest Inventory. Standard reports, Table 5.0, Area (1000 ha) of forest land by forest type and age class in Canada. https://nfi.nfis.org/resources/general/summaries/en/html/CA3_T5_FORAGE20_AREA_en.html (accessed May 1, 2017).

Forest ownership

National Forest Inventory. Standard reports, Table 12.0, Area (1000 ha) of forest land by ownership in Canada. https://nfi.nfis.org/resources/general/summaries/en/html/CA3_T12_FOROWN_AREA_en.html (accessed May 1, 2017).

Growing stock

National Forest Inventory. Standard reports, Table 15.0, Total tree volume (million m^3) on forest land by forest type and age class in Canada. https://nfi.nfis.org/resources/general/summaries/en/html/CA3_T15_FORAGE20_VOL_en.html (accessed May 1, 2017).

National Forest Inventory. Standard reports, Table 16.0, Total tree volume (million m^3) by species group and age class in Canada. https://nfi.nfis.org/resources/general/summaries/en/html/CA3_T16_LSAGE20_VOL_en.html (accessed May 1, 2017).

Disturbance

Insects

National Forestry Database. Forest insects – Forest insects 2015, Area of moderate to severe defoliation and beetle-killed trees by major insects. http://nfdp.ccfm.org/insects/quick_facts_e.php (accessed June 30, 2017).

- Data include those areas where there is tree mortality and moderate to severe defoliation. Defoliation does not always imply mortality. Defoliation data is collected on an insect-species basis. Because any forested area can be defoliated by more than one insect, there may be considerable overlap in the reported figures. The area within which there is moderate to severe defoliation can also include roads, cultivated areas, small lakes and burned areas.

Fire

National Forestry Database. Forest fires – National tables, Table 3.1, Forest fire statistics by province/territory/agency, 1990–2016. http://nfdp.ccfm.org/data/compendium/html/comp_31e.html (accessed June 30, 2017).

- National data include all burned areas within Canada's forests. Provincial data do not include fires within national parks. In 2015, 84 fires burned 282,131 hectares in national parks across Canada. Some of these fires were controlled or prescribed burning for ecological restoration purposes.

Forest management

Harvesting

National Forestry Database. Forest products – Forest products, 2015, Total roundwood production by ownership and species. http://nfdp.ccfm.org/products/quick_facts_e.php (accessed June 30, 2017).

National Forestry Database. Silviculture – Silviculture, 2015. http://nfdp.ccfm.org/silviculture/quick_facts_e.php (accessed June 30, 2017).

- The national and provincial/territorial profile figures for harvesting volumes include data for industrial roundwood, fuel wood and firewood from provincial and territorial Crown land and from private land.

Regeneration

National Forestry Database. Silviculture – Silviculture, 2015. http://nfdp.ccfm.org/silviculture/quick_facts_e.php (accessed June 30, 2017).

- The national and provincial/territorial profile figures for area planted and area seeded include data from federal, provincial and territorial Crown land and from private land.

Third-party certification

Certification Canada. Canadian statistics. http://certificationcanada.org/en/statistics/canadian-statistics/ (accessed March 14, 2017).

- If a forest area has been certified to more than one of the three sustainable forest management standards (Canadian Standards Association [CSA], Sustainable Forestry Initiative [SFI], and Forest Stewardship Council [FSC]), the area is counted only once. Therefore, the total certification for sustainable forest management standards may be less than the sum of the individual totals for these standards. The independently certified forest area is calculated using Forest Management Units (FMUs), which include streams, lakes, rivers and roads.

Protected forest

National Forest Inventory. Standard reports, Table 9.0, Area (1000 ha) of forest land by IUCN category and age class in Canada. https://nfi.nfis.org/resources/general/summaries/en/html/CA3_T9_PSAGE20_AREA_en.html (accessed May 1, 2017).

Greenhouse gas inventory

Source

Environment and Climate Change Canada. 2017. *National inventory report 1990–2015: Greenhouse gas sources and sinks in Canada.* www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=662F9C56-1

- Environment and Climate Change Canada's *National Inventory Report 1990–2015* uses Natural Resources Canada–Canadian Forest Service's National Forest Carbon Monitoring, Accounting and Report System data and analysis.

- For forest lands affected by land-use change, the deforestation and afforestation figures reflect annual rates. Figures for CO_2 equivalent (CO_2e) emissions and removals reflect the current year plus the previous 20 years. Thus, the figures for CO_2e emissions include residual emissions from areas deforested over the past 20 years, and the figures for CO_2e removals include ongoing removals by areas afforested over the past 20 years.

- Emissions bear a positive sign. Removals bear a negative sign.

- See the sources and information for the sustainability indicator *Carbon emissions and removals* on page 41 for more detail.

Domestic economic impact

Canadian housing starts

Statistics Canada. CANSIM table 027-0009: Canada Mortgage and Housing Corporation, housing starts, under construction and completions, all areas. http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=0270009 (accessed March 21, 2017).

- A rate adjustment is used for economic or business data to remove seasonal variations in the data. The time of year will affect most data. Adjusting for the seasonality in data enables more accurate month-to-month comparisons. The seasonally adjusted annual rate (SAAR) is calculated by dividing the unadjusted

annual rate for the month by its seasonality factor and creating an adjusted annual rate for the month. These adjustments are most often used when economic data are released to the public.

Contribution to nominal GDP

Natural Resources Canada–Canadian Forest Service calculations based on Statistics Canada's CANSIM table 379-0031: Gross domestic product (GDP) at basic prices, by North American Industry Classification System (NAICS).

- GDP is a measure of the economic production that takes place within the geographical boundaries of Canada. Nominal GDP is measured in current dollars and is available only for Canada. Current dollars are used to describe the value of production in any given year.

- Data from Statistics Canada's new Natural Resources Satellite Account (NRSA) are a key source of information on the economic contribution of the forest sector in Canada and will be included in future releases of The State of Canada's Forests report. The NRSA, the result of collaboration between Natural Resources Canada and Statistics Canada, is able to capture economic activity in forest industry segments that have traditionally been difficult to measure, such as wood furniture manufacturing. According to data from the NRSA, the forest sector directly accounted for $25.2 billion (or 1.3%) of Canada's nominal GDP in 2016.

Contribution to real GDP

Statistics Canada. CANSIM table 379-0030: Gross domestic product (GDP) at basic prices, by North American Industry Classification System (NAICS), provinces and territories. http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=3790030 (accessed March 22, 2017).

Statistics Canada. CANSIM table 379-0031: Gross domestic product (GDP) at basic prices, by North American Industry Classification System (NAICS). http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=3790031 (accessed May 26, 2017).

- GDP is a measure of the economic production that takes place within the geographical boundaries of Canada. Real GDP is measured in 2007 dollars and corrects for inflation, enabling accurate comparisons between years.

Revenue from goods manufactured

Statistics Canada. CANSIM table 301-0008: Principal statistics for manufacturing industries, by North American Industry Classification System (NAICS). http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=3010008 (accessed March 20, 2017).

Statistics Canada. CANSIM table 301-0009: Logging industries, principal statistics by North American Industry Classification System (NAICS). http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=3010009 (accessed March 20, 2017).

- Revenue from goods manufactured includes revenue from the sale of goods manufactured using materials owned by the establishment, as well as from repair work, manufacturing service charges and work contracted to others.

Forest industry employment

Employment

Statistics Canada. Labour Force Survey (special extraction) (accessed March 14, 2017).

Statistics Canada. CANSIM table 281-0024: Survey of Employment, Payrolls and Hours (SEPH), employment by type of employee and detailed North American Industry Classification System (NAICS). http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=2810024 (accessed April 13, 2017).

Statistics Canada. CANSIM table 383-0031: Labour statistics consistent with the System of National Accounts (SNA), by province and territory, job category and North American Industry Classification System (NAICS). http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=3830031 (accessed May 26, 2017).

- Employment includes jobs held by people employed directly in the following industries: forestry and logging; support activities for forestry; pulp and paper product manufacturing; and wood product manufacturing. Natural Resources Canada prefers to use employment data from Statistics Canada's System of National Accounts (SNA) because this data is linked to the underlying framework used to compile the Canadian System of National Economic Accounts (e.g. GDP, national wealth). Employment data can also be sourced from Statistics Canada's Labour Force Survey (LFS) and the Survey of Employment, Payrolls and Hours (SEPH). The strength of LFS data is its demographic information, and it can be used to capture the level of self-employment in the forest

sector. The SEPH data focuses on industry and can be used for comparing direct company employment in forestry with that in other sectors.

- Indirect employment is calculated by Natural Resources Canada using Statistics Canada's National Symmetric Input-Output Tables (15-207-XCB) and Statistics Canada's National Multipliers (15F0046XDB).

- Data from Statistics Canada's new Natural Resources Satellite Account (NRSA) are a key source of information on the economic contribution of the forest sector in Canada and will be included in future releases of the State of Canada's Forest Report. The NRSA is the result of collaboration between NRCan and Statistics Canada and is able to capture additional economic activity in segments of the forest industry that have traditionally been difficult to measure, such as wood furniture manufacturing. According to data from the NRSA, the forest sector directly employed 221,623 people across the country in 2016.

Wages and salaries

Statistics Canada. CANSIM table 301-0008: Principal statistics for manufacturing industries, by North American Industry Classification System (NAICS). http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=3010008 (accessed March 21, 2017).

Statistics Canada. CANSIM table 301-0009: Logging industries, principal statistics by North American Industry Classification System (NAICS). http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=3010009 (accessed March 21, 2017).

- Wages and salaries are the earnings, in cash or in kind, of Canadian residents for work performed before deduction of income taxes and contributions to pension funds, employment insurance and other social insurance schemes.

Trade

Statistics Canada. Merchandise trade data (special extraction), monthly data.

- Balance of trade is the difference between the value of the goods and services that a country exports domestically and the value of the goods and services that it imports. If a country's exports exceed its imports, it has a trade surplus. If its imports exceed exports, the country has a trade deficit.

Domestic production and investment

Production

APA – The Engineered Wood Association.

Pulp and Paper Products Council.

Statistics Canada. CANSIM table 303-0064: Lumber production, shipments and stocks, by Canada and provinces. http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=3030064 (accessed March 20, 2017).

- Production and consumption figures for newsprint, printing and writing paper, and wood pulp are based on data of the Pulp and Paper Products Council. The production and consumption data of structural panels (plywood and oriented strand board) are from APA – The Engineered Wood Association.

Capital expenditures and repair expenditures

Statistics Canada. CANSIM table 029-0045: Capital and repair expenditures, by North American Industry Classification System (NAICS), Canada, provinces and territories. http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=0290045 (accessed March 21, 2017).

- Capital expenditures include the costs of procuring, constructing and installing or leasing new durable plants, machinery and equipment, whether for the replacement of or addition to existing assets. Also included are all capitalized costs, such as costs for feasibility studies and architectural, legal, installation and engineering fees; the value of capital assets put in place by firms, either by contract or with the firm's own labour force; and capitalized interest charges on loans for capital projects.

- Repair expenditures include costs to repair and maintain structures, machinery and equipment.

Domestic consumption

Consumption figures for a range of products, calculated by Natural Resources Canada.

- This information is available only at the national level.

- Domestic consumption of wood pulp (tonnes) contains CFS estimates of import volumes that may be subject to revision.

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Natural Resources Canada

580 Booth Street,
Ottawa, ON K1A 9Z9

Reader feedback

What information or section in this year's report was the most useful to you?

What category best describes your affiliation?

- ☐ Provincial/territorial government
- ☐ Federal government
- ☐ General public
- ☐ Industry
- ☐ Education
- ☐ International
- ☐ Other

What topics or changes would you suggest for future editions of the report?

Please provide any additional comments or suggestions you have related to this report.

cfs.nrcan.gc.ca/stateoftheforests